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R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook

C. Kerry Overton
Sherry P. Wollrab
Bruce C. Roberts
Michael A. Radko

The Authors

C. Kerry Overton is a Technology Transfer Specialist with the Intermountain Research Station's Enhancing Fish Habitats Research Work Unit in Boise, ID. He received B.S. degrees in conservation and biology and an M.S. degree in zoology (aquatic ecology) from Idaho State University. He joined the Forest Service in 1978 and has worked as a fishery biologist at the District, Forest, and Regional levels in the Pacific Southwest Region, California. He joined the Intermountain Research Station in November of 1990 working on the development, evaluation, and transfer of technical tools to assist National Forest fisheries biologists.

Sherry P. Wollrab is a Fisheries Biologist with the Intermountain Research Station's Enhancing Fish Habitats Research Work Unit in Boise, ID. She received a B.S. degree in wildlife management from the University of New Hampshire in 1988. She joined the Intermountain Research Station in 1993 after working for the States of New Hampshire and Wyoming on projects involving wetland inventory, species information systems, and wildlife habitat enhancement. She is currently involved in fish habitat inventory and database management.

Bruce C. Roberts is presently working as a Zone District Fisheries Biologist on the Wise River and Wisdom Ranger Districts of the Beaverhead National Forest, Montana. He worked as the R1/R4 fish habitat inventory coordinator for Region 4 stationed out of the Intermountain Research Station in Boise, ID, from June 1991 to July 1994. He received his B.S. degree from the University of Idaho in fisheries resources in 1985 and an M.S. degree from Montana State University in Fish and Wildlife Management in 1988. He began his career working for the Utah Division of Wildlife Resources as a Wildlife Biologist working on Colorado squawfish on the San Juan River in southeastern Utah. He started his Forest Service career in May 1989 working for the Manti-La Sal National Forest, Utah, as a fisheries biologist.

Michael A. Radko is a Fisheries Biologist with the Intermountain Research Station's Enhancing Fish Habitats Research Work Unit in Boise, ID. He received his B.S. degree in zoology from the University of Nevada and has pursued graduate study in fisheries biology. He began work with the Forest Service in 1990 and is currently involved with aquatic habitat inventories, fish habitat relationships, and Geographic Information Systems.

Research Summary

Fishery biologists working for the Forest Service, U.S. Department of Agriculture, are required to assess the direct, indirect, and cumulative effects of National Forest management activities on fish and fish habitat. This requires an understanding of the conditions, processes, and interactions between the human, aquatic, riparian, and terrestrial features at multiple landscape scales. Data characterizing fish and fish habitat are required to complete these evaluations. Such data must be standard to compare and contrast across the landscape from fine to broad scale.

This handbook describes the standard inventory procedures for collecting fish habitat and salmonid fish species data for streams managed by the Northern Region (R1) and Intermountain Region (R4) of the Forest Service. The inventory defines the structure (pool/riffle, forming features), pattern (sequence and spacing) and dimensions (length, width, depth, area, volume, and so forth) of fish habitat; describes species composition, distribution, and relative abundance of salmonid species; and facilitates the calculation of summary statistics for habitat descriptors.

A standard core-set of fish habitat variables and their measurement protocols helps the user observe and contrast fish population and habitat status and condition across multiple landscape scales. The successful implementation of site-specific projects, watershed analyses, and PACFISH standards and guidelines require standard data elements for extrapolation and monitoring and must fall within the constraints of personnel and budgets. Moreover, a standarized data collection system is the only affordable (time and funds) approach for applying research and decision support tools and transferring information across broad geographical areas and to a diverse group of resource specialists and managers.

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324 25th Street
Ogden, UT 84401

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Introduction

Fishery biologists working for the Forest Service, U.S. Department of Agriculture, are required to assess the direct, indirect, and cumulative effects of National Forest management activities on fish and fish habitat. This assessment requires an understanding of the conditions, processes, and interactions between the human, aquatic, riparian, and terrestrial features at multiple landscape scales. Data characterizing fish and fish habitat are required to complete these evaluations. The data must be standard to compare and contrast across the landscape from fine to broad scale.

This document describes the standard inventory procedures for collecting fish habitat and salmonid fish species data for streams managed by the Northern (R1) and Intermountain (R4) Regions of the United States Forest Service.

This inventory was designed to:

1. Define the structure (pool/riffle, forming features), pattern (sequence and spacing), and dimensions (length, width, depth, area, volume, and so forth) of fish habitat.
2. Describe species composition, distribution, and relative abundance of salmonid species.
3. Facilitate the calculation of summary statistics for habitat descriptors.

These multiple scale (reach, stream, watershed, basin) fish and fish habitat data, in combination with other biophysical data (vegetation, hydrology, water quality, natural and human disturbance, and so forth), will assist natural resource specialists in making better informed management decisions. Specifically, these data will help to identify factors limiting fish populations, to define current and potential status of fish and fish habitat, to complete local and regional population viability assessments (extinction risks), and to correlate fish and fish habitat distributions and conditions with environmental parameters, past and current land use, and natural disturbance.

Inventory Variables

The identification of a standard core-set of variables and protocols began in 1990 at the Intermountain Station's Enhancing Fish Habitats Research Work Unit, in collaboration with fisheries scientists, biologists, and hydrologists throughout the Forest Service and other State and Federal agencies. The selection of variables was the most challenging aspect of the inventory development. The variables presented in this document were chosen because (1) most are quantitative and repeatable, (2) they are ecologically relevant to fish and responsive to changing environments, (3) they can be taught to inexperienced field technicians with reasonable expectations for accurate, consistent data, and (4) they can be collected at an intensive or extensive level depending on the sampling objectives. Although we need more information linking fish requirements and abundance to habitat attributes, we believe these variables are the best to date until further research strengthens our understanding of fish habitat relationships.

Why Have a Standardized Inventory?

If we have "standard" procedures, then a common set of variables is collected in a consistent manner. The data storage and retrieval program (FBASE) provides easy transfer of information between and among agencies. A standardized inventory gives us the capability to observe and contrast fish population and habitat status and condition across multiple landscape scales. Broad-scale assessments and strategies such as the Columbia Basin Anadromous Fish Policy and Implementation guidelines (USDA 1991) and the Pacific Salmon Conservation Strategy (PACFISH) (USDA and others 1995). These require a common set of habitat descriptors that can be compared across the landscape. The successful implementation of site-specific projects, watershed analyses, and PACFISH standards and guidelines require standard data

elements for extrapolation and monitoring. The standards and guidelines must fall within the constraints of personnel and budgets. Finally, a standard inventory provides the only affordable (time and funds) approach for applying research and decision support tools and transferring information across broad geographical areas and to a diverse group of resource specialists and managers.

Inventory Data Stratification Scheme

We selected certain variables to enable us to nest inventory data (site, reach, and stream) within larger landscape scales (watershed, basin, and ecoregion) for multiscale characterization and comparisons. For example, streams, watersheds, and basins can be grouped by like geology, climate, vegetation, and topography. Habitat attributes, habitat types, and stream reaches can be grouped by similar hydrologic function and sediment regimes. The stratification scheme gives us the flexibility to integrate the inventory data with other resource data at a given scale and to compare management effects on fish and fish habitat at various levels.

Sampling Design

The large disparity between National Forests in personnel, funding, and inventory support necessitates different sampling strategies to fit available resources and inventory needs. We present three sampling schemes, ranging from Level I (least intensive) to Level III (most intensive), which differ in the number of variables collected. In addition, subsampling strategies reduce the frequency of data collection for some variables. We describe sampling options more thoroughly later in this document

Inventory Sections

This document divides the inventory procedure process into five sections:

I. **R1/R4 Fish Habitat Inventory Overview** briefly describes each sequential step of data collection and processing from start to inventory finish.

II. **R1/R4 Fish Habitat Inventory Procedures** describes the variables collected and the methodology for the fish habitat inventory and fish population sampling.

III. **Inventory Training** provides the procedures used to introduce inventory crews to the fish habitat inventory and the suggestions for conducting crew training sessions.

IV. **Inventory Quality Control** describes techniques that crew supervisors can use to improve the inventory skills of their crews.

V. **Inventory Sampling Schemes** describe the different inventory levels (Levels I to III) and subsampling frequencies (20 to 100 percent) in relation to common Forest objectives and outputs.

Appendix A provides data forms used in the inventory process, appendix B provides an example of completed inventory forms, appendix C is a glossary, appendix D lists equipment needed to complete the inventory, appendix E contains a key for identifying riparian community types, and appendix F displays summary variable outputs using a database management system (FBASE).

I. R1/R4 Fish Habitat Inventory Overview

Experienced personnel recognize a four-step process as crucial to assuring high quality data and a timely and orderly flow of data collection and processing. These steps are the preinventory process, inventory process, postinventory process, and data entry and reporting process. Table 1 shows the average time needed to complete each step. A check list, figure 1, assists the user in tracking the inventory steps through the postinventory process.

1. Preinventory Process

Identify and Prioritize Streams—Streams and survey reaches need to be identified and prioritized before the field season. We recommend these considerations when planning the inventory field season:

- *Base-Level Flows*: R1/R4 Fish Habitat Inventory is designed to quantify available fish habitat at base-level flows. Lower elevation (below 5,000 feet or 1,525 m) snowmelt in Regions 1 and 4 normally occurs earlier than higher elevation snowmelt of late May to early July. This time lag allows for base flow inventories to be conducted in March and April. After higher elevation snowmelt of May and June, streams with small drainage areas should be inventoried first.
- *Crew Safety*: Remote streams that require backpacking should be inventoried during the summer months when inclement weather is less likely to occur. Early spring and fall inventories should be conducted where crews can work out of their residence, guard stations, or other living quarters.
- *Chinook Salmon Spawning*: The chinook salmon (spring and summer runs) is officially listed as an Endangered Species under the Endangered Species Act. Section 7 of the Act prohibits the taking and harassment of an individual fish or destruction of habitat by any Federally proposed or authorized action that includes stream inventories. To

Table 1—Estimated time to complete each inventory step assuming the Level III R1/R4 Fish Habitat Inventory is conducted.

Inventory step	Time to complete	Per unit
Identify and prioritize streams	0.5 days	All streams
Delineate survey reaches	15 minutes	Survey reach
Describe and mark survey reaches on maps	30 minutes[a]	Survey reach
Complete header forms	30 minutes	Survey reach
Collect field inventory data	10 hours	60-80 habitat units
Proof data forms (in the field)	5 minutes	20 habitat units
Describe survey reach characteristics	15 minutes	Survey reach
Fish population sampling (snorkeling)		
Small stream	1 day	20-30 habitat units
Large stream	1 day	15-20 habitat units
Label and organize slides	1.5 hours	36-exposure roll
Proof data forms (in the office)	30 minutes	100 habitat units
Photocopy and file inventory forms	1 hour	Survey reach
Enter data - Header data	3 minutes[b]	Survey reach
- Habitat data	1 hour[b]	30-60 units
- Fish data	1 hour[b]	30-60 units
- Large woody debris and riparian data	1 hour[b]	60-90 units
Proof entered data	1 hour	100-150 units
Print reports	3 minutes	1 report

[a]Add 1 to 2 days per stream if crews ground-truth and flag survey reach boundaries prior to the inventory.
[b]The time it takes to complete the data entry depends largely on the experience and skill of data entry personnel; these are gross estimates only.

assure no taking or harassment, inventories in survey reaches with known spawning areas will not be conducted during spawning. Inventories can resume when spawning activities for spring chinook salmon have ceased, but every precaution should be taken to avoid chinook salmon redds.

- *Water Temperatures*: Thurow (1994) suggests that fish surveys using snorkeling techniques occur at water temperatures greater than 9 °C. This will increase fish observability because fish are more active, and it will precede fall out-migration of anadromous parr from small tributaries. In survey reaches that require fish inventories, sampling should be scheduled for July and August.
- *Data Urgency*: Streams are often prioritized by data needs for documents required for National Environmental Policy Act or Endangered Species Act compliance, Watershed Analyses, and so forth. Base-level flows, threatened and endangered species, and crew safety should always be given priority over deadlines.
- *Transportation Scheduling*: Remote inventories often require alternative methods of transportation (rafts, pack strings, aircraft) that require prior scheduling and safe conditions.

Delineate Survey Reaches—Survey reaches **must** be delineated using named and large (at least 10 percent of main channel flow) unnamed perennial tributaries identifiable on 1:24,000 scale topographic maps. If two named tributaries converge opposite of each other or converge within 200 m of each other (same or opposite banks), choose one of the named tributaries as your survey reach boundary, not both; or if an EPA reach break occurs at one named tributary, choose it as the survey reach boundary.

Stream reaches may also be delineated if a reach type changes within the bounds of the tributary reach breaks. Reach types ("A," "B," and "C") are determined on the basis of gradient (table 2). If the gradient changes substantially enough to categorize the reach as a different reach type, the survey reach may be broken at this gradient change. However, the field crew must be able to identify this break both on a map and in the field, either by using a Global Positioning System (GPS) unit or by identifying a landmark that is permanent in the field as well as on a 1:24,000 topographic map. If there is a landmark that is close, but not right on the gradient break, use the landmark as the survey reach boundary and calculate the gradient using that boundary. Survey reach breaks may

STREAM		REACH BOUNDARIES	HEADER FORMS	FIELD DATA				SLIDES		INVENTORY FORMS		
Name	Prioritize	Describe & Map	Complete	Collect	Proof	Describe Reach	Snorkel	Label	Organize	Proof	Photocopy	File

Figure 1—Checklist for the inventory process.

Table 2—Reach type designations using map gradient and typical characteristics.

Reach type code	Map gradient	Typical characteristics
	Percent	
"A"	More than 4.0	Steep channel, with moderate to high valley confinement (less than 1.5; the width of the channel and the valley are similar); these are primarily high energy reaches that transport debris and sediment (colluvial materials), characterized by cascading, step-pool habitat types. These are sediment "source" or "erosional" stream channels.
"B"	1.5-4.0	Moderate stream gradient with moderate valley confinement. These are sediment and debris "transport" or "erosional" channels dominated by riffles and scour formed pools associated with large woody debris, bedrock, and boulders.
"C"	Less than 1.5	Low gradient, unconfined stream channel carved through alluvial materials with a well-defined floodplain within a broad valley. Pools and riffles are formed by flow divergence associated with meandering, large woody debris, riparian vegetation, and boulders. These are referred to as "response" or "depositional" channels.

also occur at management boundaries (such as an allotment fence) or at a Rosgen channel type (also called stream type) change (Rosgen 1994). Again, reach breaks must be delineated accurately on a map and in the field.

Survey reaches are determined before the field inventory to help the crew identify the reach breaks. The survey reaches are then flagged at the lower and upper boundaries in the field. Survey reach boundaries may also be changed in the field if warranted; for instance, if an unnamed tributary that contributes over 10 percent flow to the main channel occurs and was not delineated as a reach break on the map. If reach break changes are made in the field, the header forms must be adjusted to reflect that change.

Survey reaches should not be confused with EPA reaches, which are represented by a 15-digit number that identifies a reach (or subreach) of a river or stream between two of three locators (U.S. Environmental Protection Agency 1986): mouth, named tributaries, and headwaters. EPA reaches can encompass numerous survey reaches, but survey reaches will not overlap multiple EPA reaches. In some cases, they may coincide.

Describe and Mark Survey Reaches on Maps—Mark survey reaches on a 7.5 minute topographic map, make three photocopies of these maps, and highlight the reach extent. Give each crew member a map; the third copy along with the original should remain in the office with all other survey reach documentation. Also give crews all adjacent maps that show access routes to and from survey reaches. Document lower and upper survey reach boundaries on the header data form. Each boundary identifier is limited to 48 characters. For example: Lower boundary—"Unnamed trib mouth, left bank, T13N;R32E;S13" and upper boundary—"Unnamed trib mouth, right bank, T13N;R32E;S14." If possible, use ¼ Section and 1/16 Section to describe upper and lower survey reach boundaries or Global Positioning System coordinates.

If a survey ends in the headwaters, be as accurate as possible when showing the end of the reach on the map and when describing the upper boundary in the header form. Note on the field map where the approximate end of the survey occurs. Also estimate and record the elevation of the upper survey reach extent when describing the upper survey reach boundary on the header form.

Fill out Header Form(s)—The Header Form (Form 1—see appendix A for all forms) is used to locate and describe a particular survey reach. A header form **must** be filled out for **each** new survey reach **before** the field crew begins the inventory. If survey reaches are added or deleted based on crew observations, change header forms and survey reach maps for all upstream survey reaches. Whenever possible, the header data forms should be completed by the crew assigned to inventory the given survey reach. This process gives the crew members familiarity with access to and location of the reach. Some header variables (such as weather and survey date) cannot be entered on the header form until the inventory is complete. These header fields are in bold on the form and are completed in the postinventory process.

Organize Equipment—Gather equipment needed for the field work. Appendix D can be used as a checklist, and figure 2 is a display of the equipment.

2. Inventory Process

The actual field inventory is just one of many inventory steps. In the past, the emphasis (both time and money) has been placed on this procedure alone. It is crucial that this step is considered relative to the other steps, thus assuring the highest quality data and a timely and orderly flow of data collection and processing.

Figure 2—Inventory equipment: (1) procedures handbook, clipboard, pencils, permanent ink pens; (2) field computer (optional); (3) 50 m drag chain; (4) two-way radio; (5) rubber ball; (6) completed header forms, survey reach maps; (7) work vest; (8) 2 m stadia rod; (9) hipboots; (10) 35 mm camera, slide film; (11) hand level; (12) hand-held thermometer; (13) 15 cm ruler; (14) flagging; (15) polarized sunglasses; (16) solar-powered calculator; (17) surface fines grid, plexiglass (optional); (18) compass; (19) access maps.

Inventory Stream Habitat—The R1/R4 fish habitat inventory is designed for a two-person crew: "Observer" and "Recorder." A third person could significantly speed up the inventory, especially in survey reaches with high quantities of large woody debris. Responsibilities should be tailored to make data collection most effective. We suggest the following duties for crew members:

Observer: Classifies habitat types and measures the variables listed on Form 2 (Habitat Inventory Form).

Recorder: Accurately records data passed on from the observer and ensures that the observer measures all variables and that the data forms have been correctly and completely filled out.

Combined Responsibilities: Forms 3, 4, and 5 can be partitioned among the crew members to maximize efficiency.

Third Crew Member (Optional): Completes the Large Woody Debris Form (Form 4) and Comments Form (Form 5).

Proof Field Data Forms—We suggest that field crews take a break every 20 habitat units or every 2 to 3 hours to look for missing data, illegible entries, missing or misplaced decimal points, or other mistakes. Checking for errors periodically allows crews the chance to backtrack, if possible, to the appropriate habitat unit and measure (if missing) or remeasure (if illegible or incorrect) the appropriate variable. Undetected errors that are caught later in the office can only be entered into FBASE as missing data (null value).

Describe Survey Reach Characteristics—Occasionally, natural events or human-related activities that affect both the quality and quantity of fish habitat are not depicted by the data collected or pictures taken. Take 10 to 15 minutes **at the completion of each survey reach** to describe, in writing, observed land management activities, natural limitations (barriers, hot springs, and so forth), sediment sources, and other pertinent observations that may assist biologists with understanding what is occurring in that particular survey reach. Write these descriptions on the back side of the header form or on a separate piece of paper with the stream name, Forest, and date. At the start of the field season, field crews should meet with the supervising biologist and discuss what information the reach description should contain. The biologist may also provide a list of reach data that they want in the description. It is important to be thorough and accurate in these reach descriptions for they often reflect the professionalism and quality of the crew, supervisor, and inventory data.

Sample Fish Population—Relative fish abundance by species and size/age classes is determined using the direct enumeration snorkeling technique as discussed in "Underwater Methods for Study of Salmonids in the Intermountain West" (Thurow 1994). Snorkeling crews,

consisting of at least two people, snorkel a select percentage of all habitat types. See part III, "Inventory Training," for a description of proper snorkeling techniques and discussions on how to correctly complete Form 6 (Fish Data).

3. Postinventory Process

Complete Header Form(s)—Fill in the remainder of the header variables on Form 1 that were collected in the field (such as survey date, weather, and so forth). The header form should now be complete.

Label and Organize Slides—Label undeveloped slide film with stream name, survey reach number(s), and crew name when film is removed from the camera. Transfer this information to the developing envelope or film mailer before the film is sent for processing. Request that the developing companies transfer this information to the return envelope or box.

File all slides taken during the inventory in a logical order in a three-ring binder with divider pages. Label the tab of each divider page with the stream name ("tributary to" in parenthesis). Label each slide with cross-referencing information from Form 5 (Comments) and place in 8.5 inch by 11 inch polyethylene slide archival pages ordered by stream, reach, and habitat unit number. Information transferred to each slide should include date (if not imprinted in the slide), stream name, survey reach number, habitat unit number, and a brief slide description. Crews who inventory a given survey reach are responsible for labeling and organizing their own slides. Do not leave the slide labeling task to the end of the season after crews have left.

Proof Field Forms in Office—As data arrives in the office, proof the inventory data forms one more time before the information is passed to data entry personnel. Remember at this point that it is too late to collect missing data or remeasure illegible or incorrect data. The crew that collected the data should not clean up their own data but should be present to answer any questions. We suggest that two crews exchange data and clean up each other's data simultaneously. Mark all data that are missing, illegible, or incorrect with a dash ("–").

Photocopy and File Inventory Forms—Photocopy and file all original data forms. An individual file should include all original data forms, two copies of the original data forms (including header forms), and a reach map. From this point on, make all changes in red **only** on the copied data forms, **not** on the original data forms. Give one copy to data entry personnel to be entered into FBASE, and store the second copy in a safe place.

4. Data Entry and Reporting Process

After the previous three steps are completed, the data are entered into FBASE. FBASE is a database software program designed exclusively to store and retrieve the inventory data. The following brief description of this process is included here because an awareness of FBASE and its capabilities may have an impact on how and what data are collected.

Enter Data—The data recorded on the forms are entered into FBASE's customized screens that look similar to the forms.

Proof and Edit Data—After the data are entered they must be proofed. It is important to do this **before** any summaries are run. This is accomplished by printing out the raw data reports, or by observing the data on the computer screens, and comparing data that have been entered to the data on the field forms. Edits are made with red ink if a printout is used and are then made in the computer, or may be made directly in the computer if using the screens.

Produce Data Reports—The many report options available in FBASE include raw data reports, which are simply printouts of the entered data, and summary reports, which contain calculated and summarized values for the stream, survey reach, reach type, and channel type. When a report is chosen, the data are summarized and printed (see appendix F for summary variables).

II. R1/R4 Fish Habitat Inventory Procedures

Form 1: Header Data

The header attributes (and data form abbreviations) on Form 1 are:

Stream
Tributary of (Trib of)
Stream ID Code (Stream ID)
Study/Year
Survey Reach Number (Survey Reach #)
Reach Type
Survey Reach Lower Boundary
Survey Reach Upper Boundary
Forest Name (Forest) and Forest Code (Code)
District Name (District) and District Code (Code)
Administering Forest Name (Admin. Forest) and Forest Code (Code)
Administering District Name (Admin. District) and District Code (Code)
Non-USFS Inclusions

Bailey Ecoregion
Omernik Ecoregion
Gross Geology and Sub-Geology
EPA Reach Number
EPA Reach Lower Boundary
EPA Reach Upper Boundary
Township/Range/Section (Location)
Base Quad
Survey Reach Latitude (Survey Lat)
Survey Reach Longitude (Survey Long)
Survey Date
Observer
Recorder
Elevation
Map Gradient (Map Grad.)
Observed Gradient (Obs. Grad.)
Rosgen Channel (Stream) Type Classification (Chan. Type)
Cover Group
Discharge
Valley Confinement (Confinement)
Weather
Wilderness
Comments
Other Variables [optional]:

Most of the information necessary to complete the header form is collected and recorded before the inventory crews go into the field to begin the stream survey. Some attributes (such as weather) obviously cannot be completed until the inventory has begun. Record these data fields as soon as that information is available. See appendix A for a blank and appendix B for a filled-out example of the R1/R4 Fish Habitat Inventory Header Data Form. With all phases of data collection, it is important that all header data fields are filled out completely with the correct information.

Identification of the header attributes and the type(s) of data needed are as follows:

Stream—Record the stream name as it appears on the 7.5 minute (1:24,000 scale) topographic map. The naming conventions for rivers and streams are as follows: River (R), Creek (Cr), Fork (Fk), South (S), North (N), East (E), West (W), and Middle (M). For example: East Fork of the South Fork of the Salmon River (Salmon R, E Fk S Fk), Little Salmon River (Little Salmon R), and East Fork of Mayfield Creek (Mayfield Cr, E Fk).

Tributary of—Record the name of the stream or river to which the inventory stream is a tributary. Use the same naming convention as described above.

Stream ID Code—Record the stream ID code from the State's Rivers Information System manual (IRIS = Idaho Rivers Information System, MRIS = Montana Rivers Information System, and so forth), if available. IRIS assigns a unique code to each stream, whereas MRIS assigns a unique code for every EPA reach on a given stream. Many smaller streams have not been assigned a unique Stream ID Code for streams that do **not** have a stream code already assigned, follow the coding convention of the following example:

41206LDP0

Where 4 (first character) = Region Code for the region in which the stream occurs; 12 (second and third characters) = Forest code for the Forest in which the stream survey occurs; 06 (fourth and fifth characters) = District code for the Ranger District in which the stream occurs; and LDP0 (sixth through ninth characters) = the stream acronym. Choose an acronym that bears some resemblance to the stream name (such as LDP0 = Lodgepole Cr) and is unique within the District. If more than one stream with the same name occurs within the District, or an unnamed tributary is inventoried, number the acronym consecutively (such as LPD0, LPD1, and so forth).

A given stream will always have the same stream ID number (or, in the case of MRIS, a given EPA reach) even if it is inventoried in different years, by different crews. If the stream crosses Regional, Forest, or District boundaries, the codes should correspond to where the mouth of the stream is. In such a situation, the coding must be coordinated with the biologist(s) residing across the boundary so that the stream has the same acronym.

The unique stream ID's that you assign are temporary. As more streams are added to IRIS and MRIS, the stream ID's you assigned may need to be updated. Make these stream ID changes on the header form (with red ink) and in the stream files in FBASE.

Utah, Nevada, and Wyoming do not have stream ID codes in a River Information System. For streams in these states, use any documented State stream coding system or the coding protocol described above for streams that do not have IRIS and MRIS codes.

Study/Year—Record the type of stream inventory conducted and the year (such as I95). Most inventories will be recorded as (I) for inventory. Other studies include historical surveys (H), desired future conditions inventories (D), and monitoring inventories (M).

Survey Reach Number—Survey reaches are numbered consecutively, starting with 1, from the mouth upstream regardless of land ownership, stream conditions, or where the survey started. This is done so that

there are no two survey reaches with the same number. Therefore, delineate the stream reaches from the mouth to where the end of your survey occurs, even if the lower reaches are not being inventoried.

Reach Type—The survey reach is classified into a reach type. Three reach types, "A," "B," and "C," are used to group survey reaches by similar channel gradient ranges. These reach types are synonymous with Montgomery and Buffington's (1993) valley segments (source, transport, and response), and Rosgen's basic channel types ("A," "B," "C") (Rosgen 1985). Classify reach types by using the map gradient determined from 1:24,000 topographic maps (fig. 3). Record the appropriate code on the field form as determined from table 2 and mark it on the map before going to the field. Figures 4, 5, and 6 show examples of "A," "B," and "C" reach types.

Reach types should be field-checked to confirm gradient calls made in the office. If large discrepancies occur between the map gradient and the field gradient, such that the reach type is different depending on the gradient used, the gradients should be remeasured and calculated to determine if an error exists. If no error exists in the field crews' measurements or calculations, determine the reach type based on the gradient that is felt to be most reliable. In other words, if the field gradient is measured with a hand level several times along the reach and matches what the observer ocularly estimates, use the field gradient to determine the reach type. If this is done, explain on the header form why the field gradient was used to determine the reach type.

If Rosgen's stream types (see "Rosgen Channel (Stream) Type Classification" later in this section) or management boundaries are used to delineate survey reaches, the reach type should still be defined for that reach using the above methods.

Survey Reach Lower Boundary—Record the name of the tributary (such as Split Cr) that represents the lower reach break, or if unnamed, record the township, range, and section (include ¼ and 1⁄16 sections if possible) where the mouth of the unnamed tributary occurs. If a reach boundary is represented by a reach type, Rosgen channel type, or a management boundary, identify the boundary and give a map or global positioning system location using legal descriptions or lat-longs (such as "Forest Boundary; T20N R10W S12 NW 1⁄16;SE ¼").

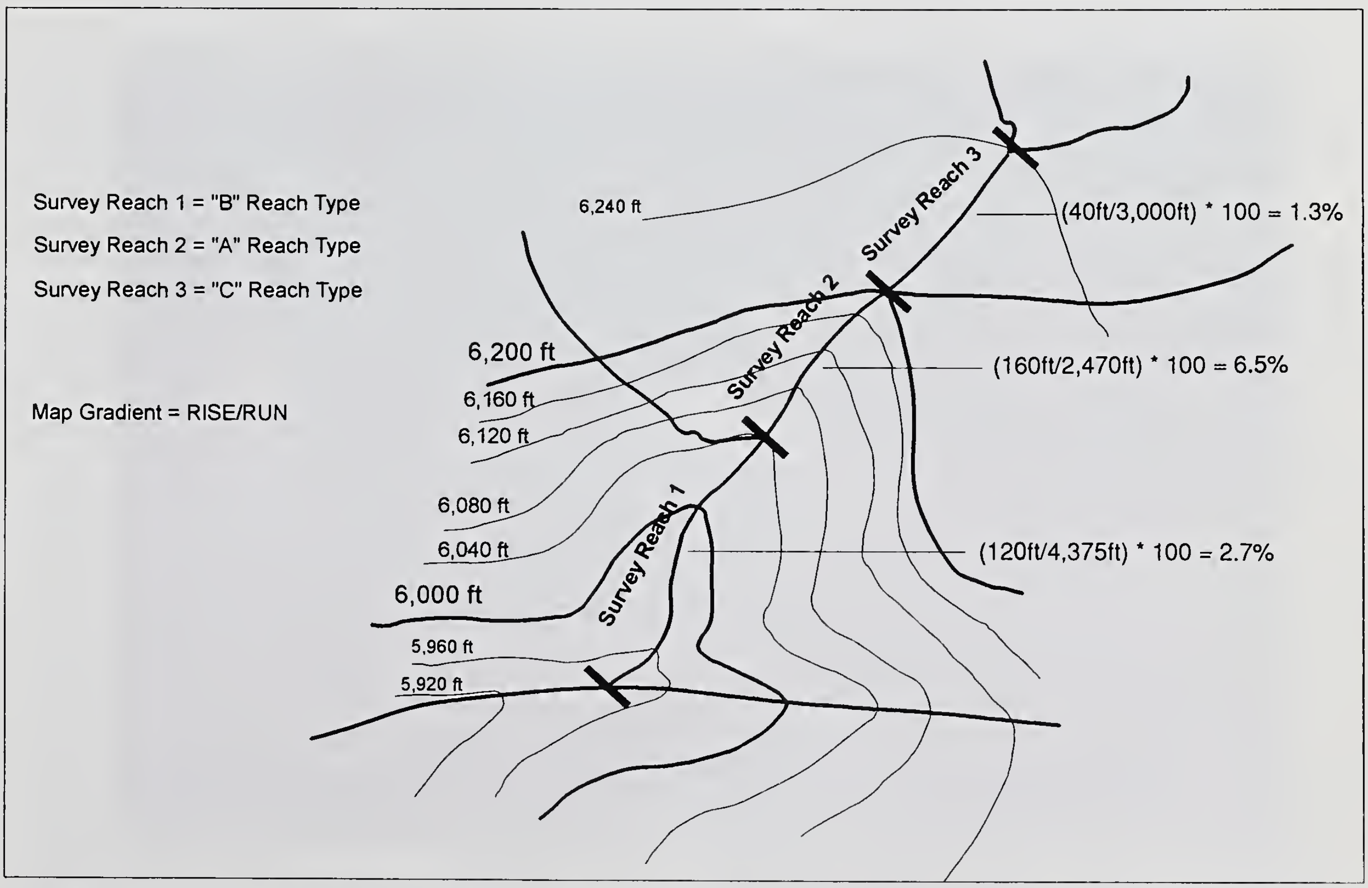


Figure 3—Calculating map gradient of survey reaches using contour lines and survey reach length.

Figure 4—Confined channel, "A" reach type, wooded cover group.

Figure 5—Moderately confined channel, "B" reach type, wooded cover group.

Figure 6—Unconfined channel, "C" reach type, meadow cover group.

Survey Reach Upper Boundary—Record the upper survey reach boundary location (see above). If the upper survey reach boundary is in the headwaters (in other words, the uppermost reach of the survey), record the township, range, and section as for the unnamed tributaries or the global positioning system coordinates. Also record the estimated map elevation for the uppermost reach.

Forest Name and Forest Code—Record the Forest name and the three-character alphanumeric Forest code as it appears in the current Forest Service directory. For example, Forest: Boise NF; Forest Code: F02.

District Name and District Code—Record the District name and the three-character alphanumeric District code. For example, District: Middle Fork RD; District Code: D04. Consult District personnel for these codes.

Administering Forest Name and Forest Code—Record the Administering Forest name and the three-character alphanumeric Forest code. Forest administration boundaries are labeled on general Forest maps (such as "Boise NF, Administered by the Challis NF"). If the Administering Forest and the Forest are the same, record the same name and code for both.

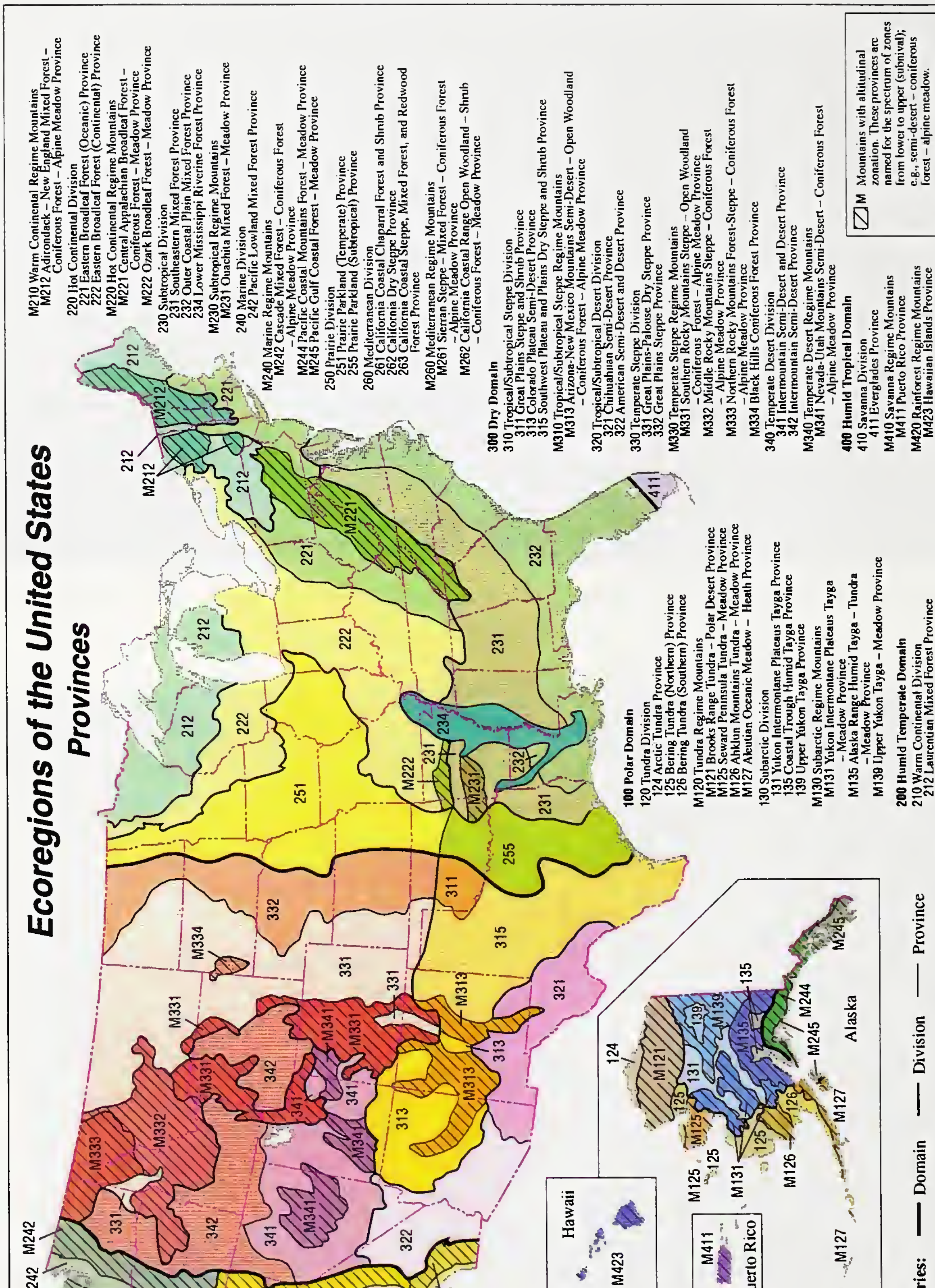
Administering District Name and District Code—Record the Administering District name and the three-character alphanumeric District code. If the Administering District and the District are the same, record the same name and code for both.

Non-U.S. Forest Service Inclusions—If any private land in holdings or lands administered by other agencies (such as Bureau of Land Management) occur on the reach, write "y" here and put the owner's name in the space provided. If the reach is administered solely by the U.S. Forest Service, put an "N" here.

Bailey Ecoregion—Record the ecoregion code from figure 7 (Bailey 1994) at the Section level (such as M332). Use the map together with the written description to code your stream.

Omernik Ecoregion—Record the two-digit numeric code from figure 8. See table 3 for a list of ecoregion names and codes (Omernik 1995) for lands administered in U.S. Forest Service Regions 1 and 4.

Gross Geology and Subgeology—Record the dominant gross (or parent) geology for the drainage basin of your survey reach (table 4). If several gross geologies exist in the basin, choose the dominant geology and include other geologies in the header form comments. To accomplish this task, access to geology



Source: R.G. Bailey [Ecoregions of the United States, USDA Forest Service (scale 1:7,500,000, revised 1994)]

Figure 7—Map of the ecoregions of the United States and ecoregion codes from Bailey (1994).

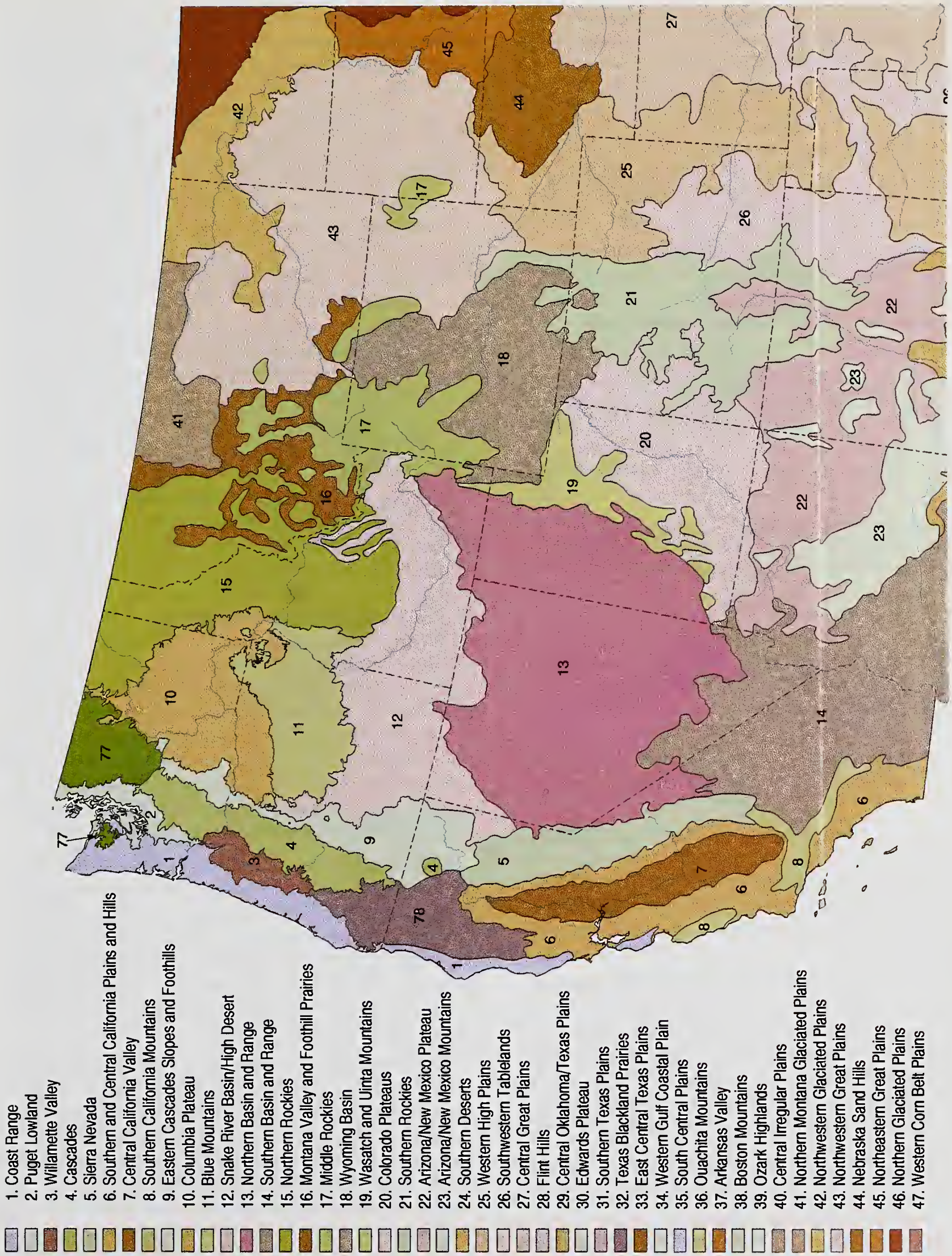


Figure 8—Map of the ecoregions and ecoregion codes from Omernik (1995).

Table 3—Ecoregion names and codes (Omernik 1995) for lands administered in U.S. Forest Service Northern (1) and Intermountain (4) Regions.

Omernik code	Ecoregion name
10	Columbia Plateau
11	Blue Mountains
12	Snake River Basin/High Desert
13	Northern Basin and Range
14	Southern Basin and Range
15	Northern Rockies
16	Montana Valley and Foothill Prairies
17	Middle Rockies
18	Wyoming Basin
19	Wyoming and Uinta Mountains
20	Colorado Plateaus
21	Southern Rockies
41	Northern Montana Glaciated Plains
42	Northwestern Glaciated Plains
43	Northwestern Great Plains

Table 4—Gross geologies and subgeologies.

Gross geology	Subgeology
Plutonic	Granite
	Diorite
Volcanic	Rhyolite
	Basalt/Andesite
Sedimentary	Fine
	Coarse
Metamorphic	Metasediment
	Quartzite

maps or assistance from the Forest or District geologist or soil scientist is needed. If the subclass can be determined, record it on the header form in the appropriate place.

EPA Reach Number—The EPA reach number is a 15-digit number that describes the stream segment (or reach). Three locators (mouth, named tributaries, and headwaters) are used to describe lower and upper boundaries for these stream segments. For example, the following represents the EPA reach number of Capehorn Creek from Banner Creek to Headwaters:

17	06	0205	034	01.00
A	B	C	D	E

A = Region (Pacific Northwest)
B = Basin (Snake River Basin excluding the upper basin above the mouth of the Salmon River)
C = Subbasin (Upper Middle Fork of the Salmon River)
D = Reach (Capehorn Creek)
E = River Mile (Capehorn Creek from Banner Creek to Headwaters). The Reach File Manual (U.S. EPA 1986) defines River Mile as a mile point that identifies a subreach within a reach. In reality, it has been used as a subreach numbering convention (such as 00, 01, 02, and so forth) without reference to river mileage. Initially, EPA reach numbers were established at the 1:250,000 scale. Later, additional named tributaries were identified at the 1:100,000 scale and were assigned their own EPA reach numbers. Rather than reassign new EPA reach numbers to all main stem rivers and streams according to the initial numbering convention, new subreaches were given the two-digit code followed by zeros after the decimal point (Reece and Butterfield 1994, personal communications). If a reach has no subreach code, record four zeros.

Use the U.S. Environmental Protection Agency "River Reach File: Hydrologic Segment Plots, Idaho" (U.S. EPA 1989) to obtain reach numbers for Idaho streams, and the "Montana Rivers Information System River Reach File" (Montana Fish, Wildlife and Parks 1995) for Montana stream reach numbers.

For surveyed streams that do not have an EPA reach number, record just the base eight numbers (hydrologic unit code) followed by five zeros. The hydrologic unit code can be found on the reach maps referred to above. Simply find the stream on the map and record the designated hydrologic unit code number. Utah, Nevada, and Wyoming do not have EPA reach numbers assigned to streams. Do not record EPA reach numbers for streams that occur in these states.

EPA Reach Lower Boundary—Record "MOUTH" or the name of the tributary that constitutes the beginning of the EPA reach. If the stream does not have an EPA reach number but does have a hydrologic unit code, record "MOUTH" for the lower EPA reach boundary. If the stream has neither an EPA reach code nor a hydrologic unit code (Utah, Nevada, and Wyoming), leave this space blank.

EPA Reach Upper Boundary—Record the name of the tributary or "HEADWATERS" that constitutes the end of the EPA reach. If the stream does not have an EPA reach number but does have a hydrologic unit code, record "HEADWATERS" for the upper EPA reach boundary. If the stream has neither an EPA reach code nor a hydrologic unit code (Utah, Nevada, and Wyoming), leave this space blank.

Township/Range/Section—Record the township, range, and section (legal description) where the survey reach (not EPA reach) begins. If possible, include the

¼ section or 1/16 section in which the survey reach begins. If ¼ section and 1/16 section are determined, record the 1/16 section first, followed by the ¼ section. See figure 9 for an example.

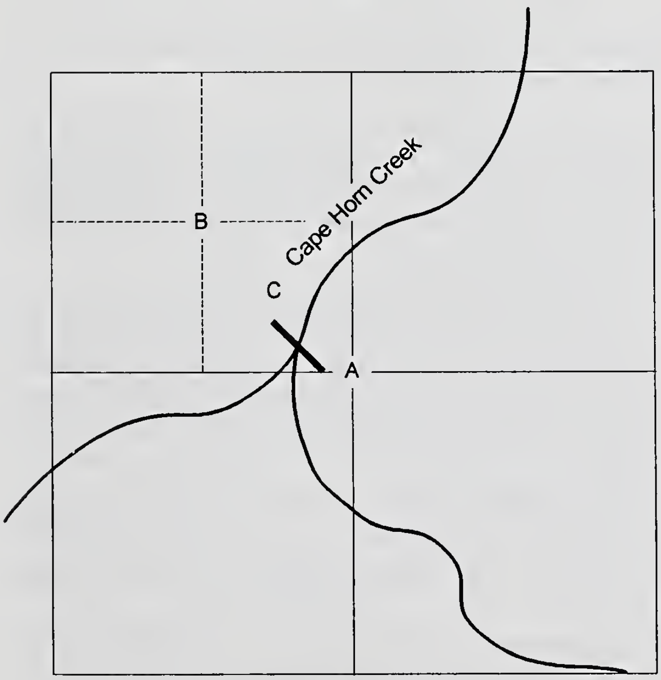
Base Quad—Record the name of the 7.5 minute topographic map in which the survey reach begins. Then list all other 7.5 minute topographic maps that encompass the survey reach.

Survey Reach Latitude—Record the latitude at the start of the reach if using a global positioning system unit. (See "GPS Pathfinder Series" [Trimble Navigation, Ltd. 1995] for specific instructions).

Survey Reach Longitude—Record the longitude at the start of the reach if using a global positioning system unit. (See "GPS Pathfinder Series" [Trimble Navigation, Ltd. 1995] for specific instructions).

Survey Date—Record the starting through the ending date (such as 7/16/95–7/25/95) of the inventory for the survey reach.

Observer—Record the name (such as J.Inventory for Joe Inventory) of the person classifying habitat types. We recommend that the same person remain the observer for a given survey reach, rather than alternating. If the crew members alternate between observer and recorder, record the name of the person classifying most of the habitat types.



A = T 12 N; R 10 E; Section 24
B = T 12 N, R 10 E; Section 24; NW1/4
C = T 12 N, R 10 E; Section 24; SE1/16; NW1/4

Figure 9—Township, range, section, and quadrant delineation used to determine reach break legal description.

Recorder—Record the name (such as I.Riffle for Ima Riffle) of the person recording the inventory data.

Elevation—Record the elevation of the start of the survey reach in meters (multiply elevation in feet by .3048 to get meters). When calculating elevation realize that some 7.5 minute topographic maps have 40 ft intervals and some have 20 or 80 ft intervals. There may be instances where adjacent maps covering the same stream reach have different intervals.

Map Gradient—Record the gradient of the survey reach calculated from a 7.5 minute topographic map to the nearest 0.1 percent. Use the RISE-over-RUN formula (RISE divided by RUN * 100 = percent gradient) for calculating map gradient. RUN is obtained from measuring the stream distance (not valley distance) for a particular survey reach from the lower to upper boundary using a map wheel. If necessary, convert inches from the map wheel to feet or meters. On a 7.5 minute topographic map, 1 inch equals 2,000 ft. The RISE is calculated from contour lines on the 7.5 minute topographic map. Estimate elevation of the lower and upper survey reach boundaries to the nearest 10 ft, and subtract the lower from higher to get the RISE (fig. 3). Because the approximate end of the uppermost survey reach may not be known before the inventory begins, calculate the map gradient for the uppermost survey reach after the inventory has been completed when a definitive survey reach break end has been mapped.

Observed Gradient—The observed gradient should be taken at 200 to 300 m intervals throughout the survey reach and averaged. Record the average gradient to the nearest 0.1 percent. The following hand level method can be used to determine observed gradient (note: We advise against the use of clinometers because of the high degree of variability when applied to stream gradients).

Choose a relatively straight section of stream at least 20 to 30 m in length, preferably between similar morphologic features (such as from the top of one riffle to the top of the next riffle). The observer first determines where their eye level is by measuring the height of eye level with a stadia rod (such as 1.6 m). This person should stand at water's edge or measure the depth of water in which they are standing and subtract later. The recorder walks upstream as far as possible while still in sight of the observer and holds the stadia rod at the water surface, while placing a hand at the height on the stadia rod equal to the observer's eye level. Looking through the hand level, the observer

centers the bubble on the hand level's cross-hairs and communicates, either by voice or hand signals, how the recorder should adjust (up or down) their hand on the stadia rod until it is at the same height as the level. The recorder makes note of this height and subtracts it from the observer's eye level height to obtain the RISE. For example, if the hand level intersects the stadia rod at the 0.8 m mark, 0.8 m is subtracted from 1.6 m for a RISE value of 0.8 m. To obtain the RUN, the horizontal centerline distance (not slope distance) of the stream is measured with a tape between these two points. Divide RISE by the RUN and multiply by 100 to calculate the percent observed gradient. For instance, if the RUN is 30 m in the above example, the percent gradient would be (0.8/30 * 100), or 2.7. Record the calculations in the header comments.

Rosgen Channel (Stream) Type Classification (Optional)—Record the Rosgen stream type based on the procedures in Rosgen's (1994) "Classification of Natural Rivers" publication. This classification identifies seven major stream types that are categorized according to entrenchment, gradient, width/depth ratio, and sinuosity in a variety of landforms.

Cover Group—For each survey reach record either wooded (forested) or meadow to characterize the dominant vegetative cover type (fig. 4, 5, and 6).

Wooded: Streamside or upslope tree stands that have the potential to supply large woody debris to the stream channel.

Meadow: Streamside or floodplain vegetation types—grass, forbs, and shrubs (including willows), that have little potential to contribute large woody debris to the stream channel.

Discharge—Record to the nearest 0.01 cubic m per second (cms) using the first straight 10 m of low gradient riffle encountered in each survey reach. A current meter should be used for calculating discharge when available and where feasible. See "Fisheries Techniques" (Nielsen and Johnson 1983) and "Methods to Estimate Aquatic Habitat Variables" (Hamilton and Bergersen 1984) for details on how to calculate discharge using this method. If a current meter is not used, discharge should be collected in the following manner:

- Find a 10 m section of low gradient riffle in the main channel that is relatively straight and has few channel obstructions.
- Place a neutrally buoyant rubber ball in the thalweg above the beginning point so that it will be at stream velocity before it enters the measured stretch.
- Record the time in seconds it takes the ball to float the 10 m.
- Float the ball at least three times and average the three measures.

Rubber balls are used because they float almost entirely submerged and provide for consistent measurements. Use the following variables and formula to calculate discharge:

$$Q = \frac{W \times D \times k \times L}{T}$$

Q = Discharge (m^3/s)

W= Average width (m). Measure wetted widths at the three transects perpendicular to the thalweg. These transects should be one-fourth, one-half, and three-fourths of the way from the bottom to the top of the habitat unit (or 2.5 m, 5.0 m, and 7.5 m if the habitat unit is 10 m long). Calculate the average of these three wetted widths.

D = Average depth (m). Measure depths at one-fourth, one-half, and three-fourths across each of the above transects. Sum all nine depths and divide by 12 (to compensate for "0" depths at each bank) to calculate average depth.

k = Velocity correction coefficient. The range of k values are 0.8 for a rough bed, and 0.9 for a smooth bed (sand, peagravel, bedrock). The commonly used value in mountain streams is 0.85.

L = Length (m) of the low gradient riffle. L = 10.

T = Time (seconds).

Valley Confinement—Determine and record the valley confinement (in other words, valley width divided by bankfull channel width) by comparing the valley confinement descriptions (fig. 10) to the reach using field observation (fig. 4, 5, and 6).

Weather—Record the weather condition or pattern that dominated the period the survey reach was being inventoried. Choose from the following conditions: clear, pt cloudy, cloudy, foggy, lt rain, hvy rain, lt snow, hvy snow, t storm, am showers, pm showers, and xtrm cold.

Wilderness—Indicate whether any part of the survey reach is in a wilderness area (YES or NO). If YES, record the name of the wilderness in the header form comments.

Comments—Record all reach-level comments on the back side of the header form.

Other Variables (Optional)—For Header Variable 1, the FBASE program allows one character (not numeric) header variable to be entered that is not part of the standard protocol. This allows the flexibility to collect a desired header (reach-level) variable, such as valley form, that is not contained on the data form. If

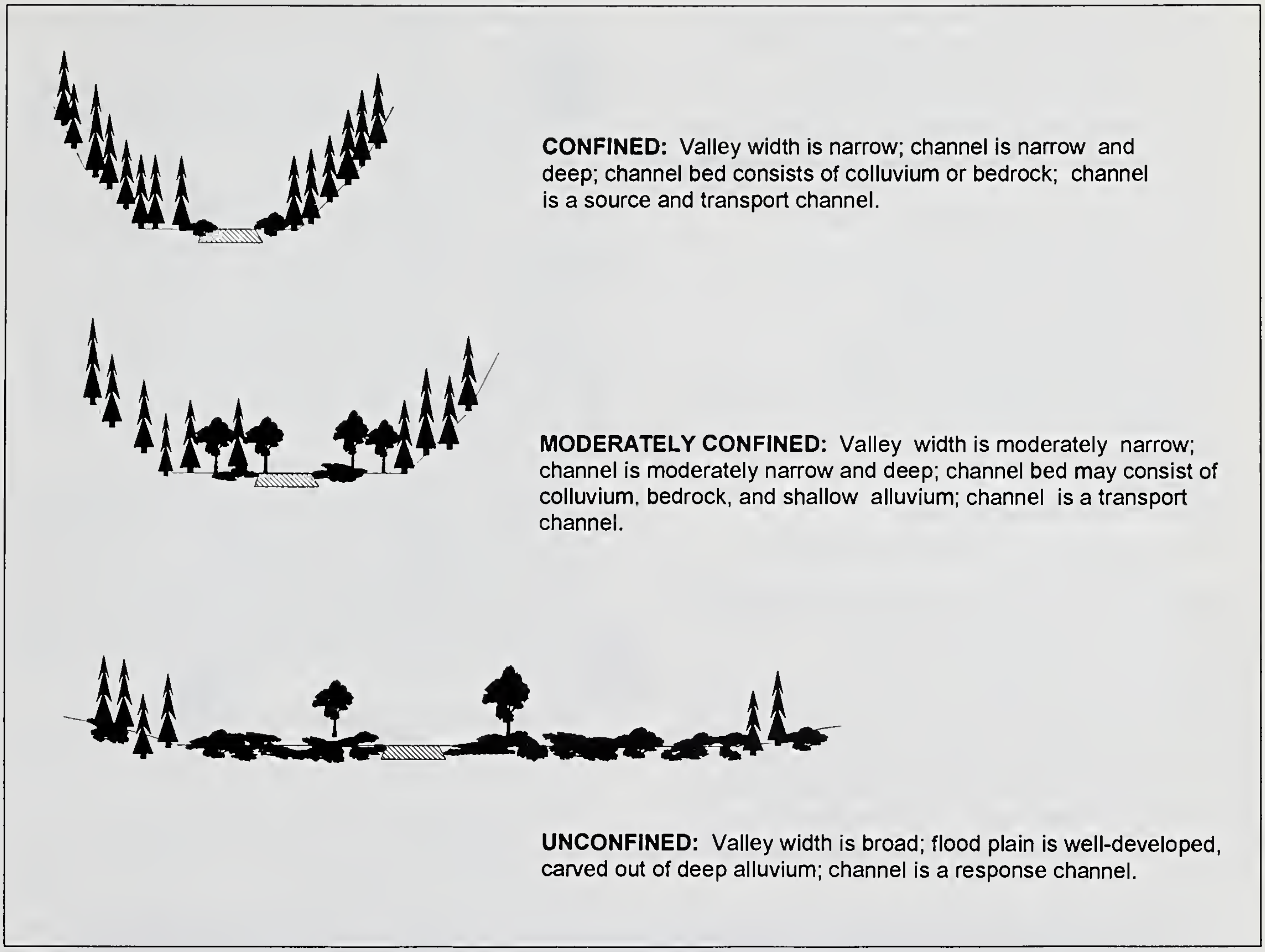


Figure 10—Valley confinement.

the option to collect this "blank" variable is chosen, the data are collected in the field and later can be entered in the FBASE program. Record these data on the back of the header form or on a separate piece of paper and explain in the header form what the data refer to (such as "Header Variable is valley form for each survey reach").

Form 2: Habitat Inventory Form

The variables collected (and data form abbreviations) on Form 2 are:

Stream
Survey Reach Number (Reach #)
Page
Forest
District
Observer
Recorder
Date
Weather
Habitat Unit Number (Habitat Unit #)
Channel Code
Side Unit Number (Side Unit #)
Habitat Type
Length
Average Wetted Width (Width)
Average Wetted Depth (Avg. Depth)
Number of Pocket Pools (# Pocket Pools)
Average Maximum Depth of Pocket Pools (Avg. Max Depth)
Pool Maximum Depth (Max Depth)
Pool Crest Depth (Crest Depth)
Step Pool Total (STP Step Pool #)
Number of Step Pools >1 m Deep (STP # Pools >1 m)
Average Maximum Depth of STP Complex (STP Avg. Max Dp)

Percent Surface Fines (Surface Fines %)
Substrate Composition (Substrate Comp.)
Bank Length (L), Bank Length (R)
Bank Stability (Stable (L), Stable (R))
Bank Undercut (Undercut (L), Undercut (R))
Channel Shape (Chan Shape (L), Chan Shape (R))
Water Temperature (Water Temp)
Air Temperature (Air Temp)
Time of Temperature (Temp Time)
Large Woody Debris Singles
Large Woody Debris Aggregates
Large Woody Debris Root Wads
Riparian Community Types (RCT1 (L), RCT2 (L), RCT1 (R), RCT2 (R))
Comments
Snorkel Tally
Other Variables [optional]

Identification of the variables is as follows:

Stream—Record the stream name as it appears on the header form. Record this information on each page in case the data forms get separated.

Survey Reach Number—Record the survey reach number (in other words, 1, 2, 3...). Survey reaches are the organized division of a stream. Reach 1 is always the survey reach starting at the mouth of the stream. If the inventory does not start at the mouth, number the survey reaches from the mouth upstream to where the survey starts and continue from there.

Page—Record the sequential page number of each habitat data form. This helps keep the pages in order and organized.

Forest—Record the name of the National Forest where the survey reach begins. Do not record the Administering Forest as on the header form. If the survey reach crosses a Forest boundary, record where this occurs (in other words, habitat unit number) in the Comments Form (Form 5). Also include in the header comments that the survey reach lies within two National Forests. "National Forest" should be abbreviated "NF" (such as Payette NF) and "National Grassland" as "NG."

District—Record the Ranger District name where the survey reach begins. Record in the Comments Form (Form 5) for a particular habitat unit where District boundaries cross the stream, if they cross within a survey reach. Also include in the header form comments that the survey reach crosses the District boundaries. "Ranger District" should be abbreviated "RD" (such as Krassel RD); "National Recreation Area" should be abbreviated "NRA."

Observer—The crew member who classifies the habitat types and measures the variables in the survey reach is the "Observer." Record this person's name in this format: J.Habitat for Jane Habitat.

Recorder—The crew member recording the data on the inventory forms is the designated "Recorder." The name is recorded as is the observer's: J.Inventory for Joe Inventory.

Date—Record the date (MM/DD/YY) of the inventory on each page. Write only one date, even if it takes more than 1 day to complete the page.

Weather—Record the dominant weather conditions occurring at the start of a page. Choose from the following conditions: clear, pt cloudy, cloudy, foggy, hvy rain, lt rain, hvy snow, lt snow, t storm, am showers, pm showers, or xtrm cold.

Habitat Unit Number—Habitat unit boundaries are defined by changes in habitat type (see "Habitat Type" later in this section). Record the number of the main channel habitat unit for which you are collecting the data. This is a sequential numbering system starting with "1" at the beginning of each new survey reach (see appendix B for an example), and progressing upstream.

Channel Code—Record an "M" if the habitat unit is in the main channel, an "S" if it is in a side channel, or an "A" if it is an adjacent habitat unit.

A side channel is a lateral channel separated by an island or mid-bar with an axis of flow roughly parallel to the main channel and is fed by water from the main channel (fig. 11, 12, and 13). Before inventorying a side channel, be sure that it is not a small tributary. Also, if the side channel is composed of just one habitat type, and the habitat type is the same as the main channel habitat type into which it flows, do not describe the side channel separately from the main channel. Instead, consider it as part of the main channel and subtract out any measurements that include the dry island (when measuring width for instance). If a side channel is present but has little or no observable flow, do not take any measurements in the side channel but record a comment on Form 5 that an insignificant side channel is present.

If a side channel occurs, first inventory the main channel unit associated with the side channel, then inventory the side channel units. The habitat unit number corresponding to a side channel represents the main channel unit where the side channel converges with the main channel on the downstream end (fig. 11).

An adjacent habitat unit is an off-channel unit (in other words, not within the main streamflow) or one that is laterally adjacent to a unit that is a different habitat type (in other words, two different habitat types occur side by side). Adjacent units typically occur within the main channel (fig. 11 and 14). To

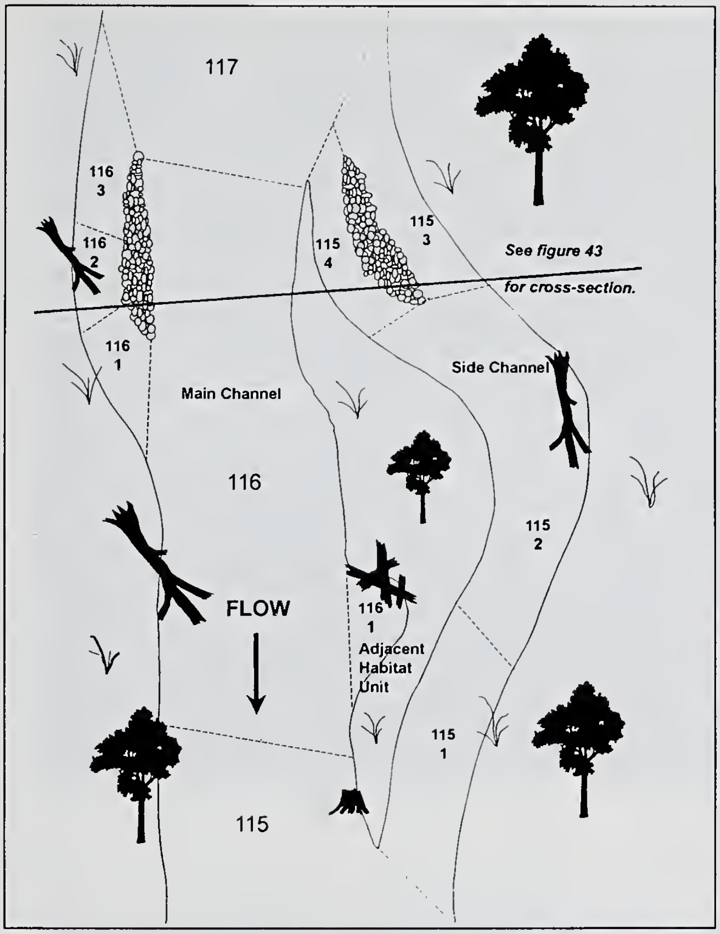


Figure 11—Numbering convention for side channel and adjacent habitat units and an example of how large woody debris is counted in main channels, side channels, and adjacent units.

Figure 12—Side channel and unvegetated island.

Figure 13—Side channel and vegetated island.

Figure 14—Adjacent habitat unit (habitat type = DBW, or dammed backwater pool formed by large woody debris).

determine whether to measure an adjacent unit separately or to include it with the main channel unit measurements, draw an imaginary line from the back of the adjacent wetted area perpendicular to the flow and to the opposite wetted margin of the main channel. If the adjacent unit is at least 30 percent of this area, measure the unit separately from the main channel; if it is under 30 percent of the area, include it as part of the main channel unit. If two habitat types occur side by side within the main channel, and the smaller unit is at least 30 percent of the area, consider the unit with the smaller area as the adjacent unit and measure each one separately.

The habitat unit number corresponding to an adjacent unit is the main channel unit in which the adjacent unit is located (fig. 11).

Side Unit Number—Place a zero in the space for side unit number if you are inventorying a main channel unit. Side unit numbers within side channels are numbered sequentially starting with "1" at the downstream end of the side channel. There may be as few as one side unit number or as many as hundreds. Regardless of how many side channel units there are in a given side channel, there is only one habitat number associated with those units (in other words, the main channel unit where the side channel and main channel converge) (fig. 11). If there is more than one side channel converging with one main channel habitat, or there is a side channel coming off of another side channel, the first side unit number of the second side channel should be the next number following the last number of the first side channel (fig. 11). For example, if there are two side channels in one main channel unit, and the first side channel has units numbering from 1 to 4, the first unit of the second side channel would be "5." Make a note in the Comments (Form 5) that there are two side channels.

If the unit is an adjacent unit, simply put a "1" for the side unit number, and number sequentially if more than one adjacent unit is located within a given main channel habitat unit (fig. 11).

When describing or notating a side or adjacent unit in the habitat comments, record the channel code and the main channel unit that corresponds to the side or adjacent unit, followed by a "-" and the side or adjacent unit number (such as S115-3 for side channel unit number "3" occurring in main channel unit "115").

Habitat Type—Record the habitat type of the main channel, side channel, or adjacent unit. Because the habitat type defines the boundaries of the habitat unit, there is only one habitat type per habitat unit. A habitat type is a discrete channel unit based on fluvial geomorphic descriptors, including flow patterns and channel bed shape (Hawkins and others 1993; McCain and others 1991). Habitat type boundaries are recognized by identifying the breaks in stream channel slope along the thalweg of the channel bottom. Individual habitat units are classified using the hierarchical scheme described below. Once the habitat type has been determined, record the three-letter acronym or code.

Table 5—Habitat classes and habitat groups (See "Form 2: Habitat Inventory Form" for definitions and descriptions).

Habitat classes	Habitat groups
FAST	Turbulent (TUR) Non-Turbulent (NTU)
SLOW	Dammed - main (DMC) Dammed - backwater (DBW) Scour - lateral (SLA) Scour - mid-channel (SMD) Scour - plunge (SPL) Scour - underscour (SUS)

Note: For reduced-level inventories, units may instead be classified by habitat class or group, which represent a broader classification of the habitat type (in other words, habitat types are nested within the classes and groups). See table 5 for the habitat classes and groups and their corresponding codes.

Fast water habitat types include channel units with moderate to fast current velocity (average velocity generally greater than 0.30 m per second [1 ft per second]). Fast water habitat types are further broken down into turbulent habitat types and nonturbulent habitat types (fig. 15), as described below:

Turbulent: Fast water habitat types exhibiting turbulence. Turbulence is the motion of water where local velocities fluctuate and the direction of flow changes abruptly and frequently at any particular location, resulting in disruption of laminar flow. It causes surface disturbance and uneven surface level and

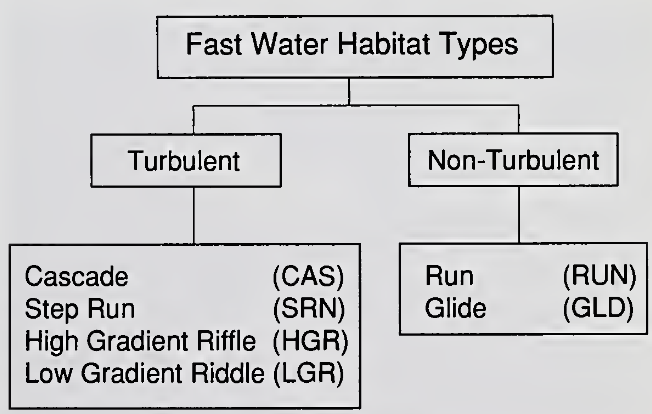


Figure 15—Fast water habitat types.

often masks subsurface areas because air bubbles are entrained in the water.

Cascade (**CAS**): A habitat unit composed of cascades, falls, steep gradient riffles (more than 7 percent), or bedrock chutes (fig. 16 and 17).

High Gradient Riffle (**HGR**): A steep and swift water habitat unit with low to moderate depth and turbulent water. Amount of exposed substrate or broken water (white water) is relatively high. Gradient is more than 4 percent (often 4 to 7 percent), and substrate is typically cobble and boulder-dominated (fig. 18 and 19).

Low Gradient Riffle (**LGR**): A habitat unit in which water flows swiftly over completely or partially submerged obstructions to produce surface agitation. The gradient is less than 4 percent. Substrate is usually gravel, small cobble, and cobble dominated (fig. 20 and 21).

Step Run (**SRN**): A series of three or more RUN's separated by short stretches of turbulent water. The

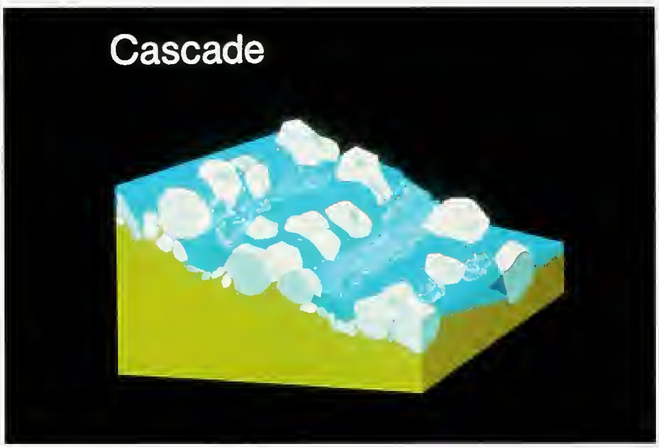


Figure 16—Cascade (CAS) habitat type schematic.

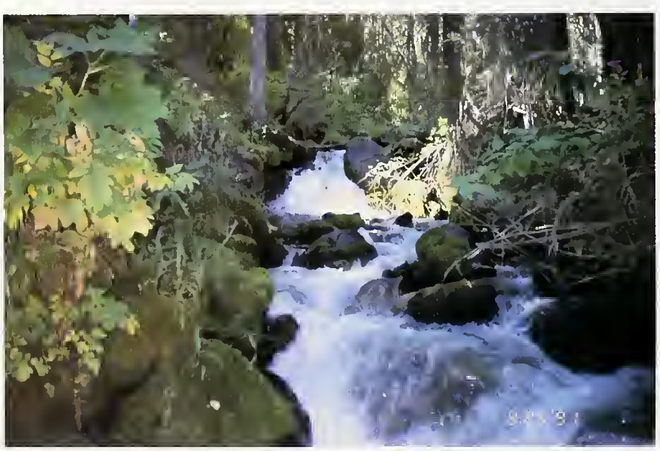


Figure 17—Cascade (CAS).

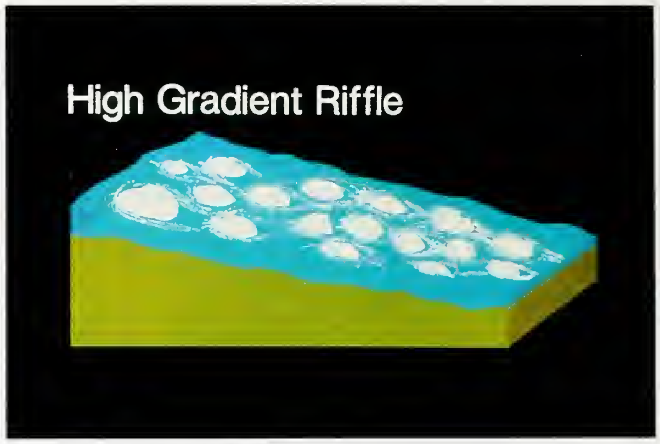


Figure 18—High gradient riffle (HGR) habitat type schematic.

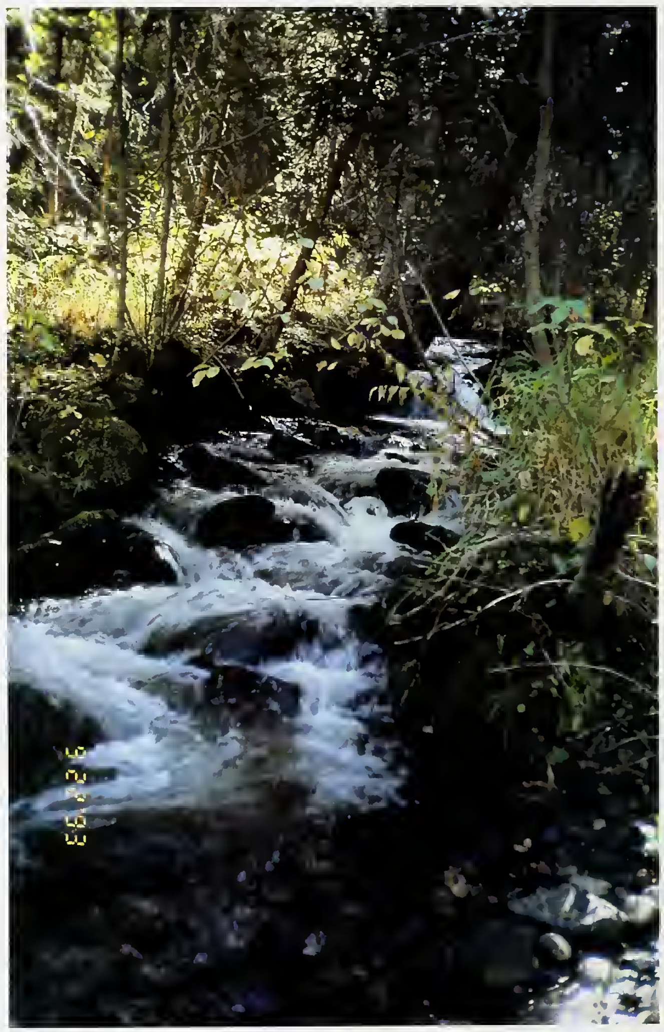


Figure 19—High gradient riffle (HGR).

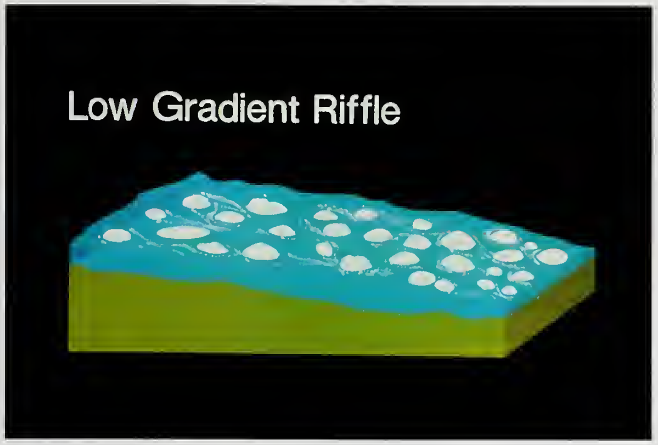


Figure 20—Low gradient riffle (LGR) habitat type schematic.

Figure 22—Run (RUN) habitat type schematic.

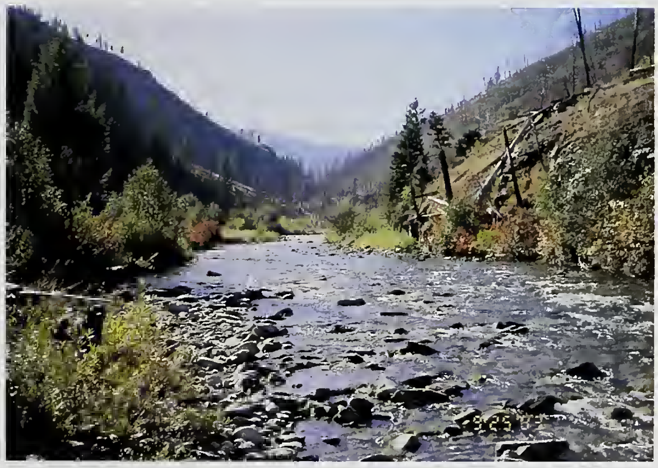


Figure 21—Low gradient riffle (LGR).

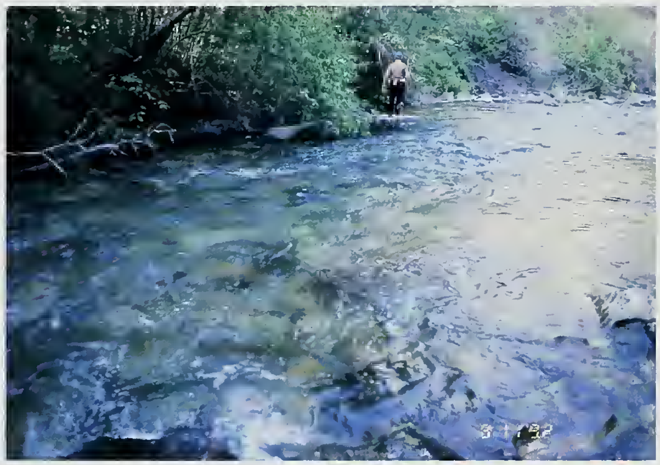


Figure 23—Run (RUN).

length of the turbulent water cannot exceed its average wetted width. If the turbulent water separating the RUN's is longer than it is wide, the turbulent water and RUN's are habitat typed and measured separately. Step runs are found only in "A" and "B" reach types.

Nonturbulent: Fast water habitat types that do not exhibit surface turbulence. These are pool like in appearance because of their depth and lack of surface agitation. However, they do not have a dished out morphology because of the lack of vertical scour. Nonturbulent habitat types are broken into "Runs" and "Glides."

Run (**RUN**): A habitat unit that is deep and fast (greater than 0.30 m per second) with a defined thalweg and little surface agitation. There may be flow obstructions in the form of boulders. Typical substrate is gravel, small cobble, cobble, small boulder, and boulders (fig. 22 and 23).

Glide (**GLD**): A habitat unit that has low to moderate velocities, no surface agitation, and no defined thalweg. The channel is a uniform U-shape with a smooth, wide bottom. Glides can appear to be pool like, but they are distinguished by having no significant scour depressions. The substrate is dominated by small materials—fines, gravel, and small cobble (fig. 24 and 25).

Slow Water Habitat Types include habitat units (often referred to as "pools") in which scouring water has carved out a nonuniform depression in the channel bed or has been dammed. Surface velocities may range from low to fast depending on channel shape and formative feature, but subsurface velocities tend to be low. Although pools are considered to be slow water habitat types, they can appear to be turbulent. They are bounded by a head crest (upstream break in slope) and a tail crest (downstream break in slope). Slow water habitat types are further broken down into

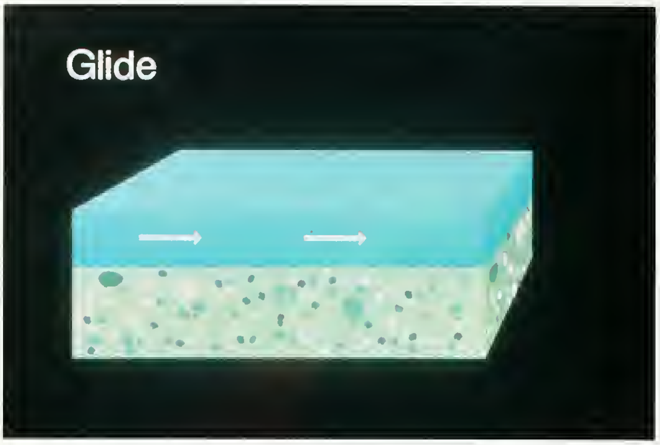


Figure 24—Glide (GLD) habitat type schematic.

Figure 25—Glide (GLD).

dammed and scour habitat types (fig. 26), as described below:

Dammed Pools: Dammed pools are formed by downstream damming action. Typically, the deepest area of a dam pool is on the downstream end of the pool (fig. 27, 28, and 29). Dam pools are categorized by pool position and formative feature:

- Position
  - Main (**M**): The dam pool is within the main body (thalweg area) of the main channel or side channel (fig. 29).
  - Backwater (**B**): The dam pool is on the channel margin or in a cove having access to the main body of water (fig. 14).
- Formative feature
  - The dam is formed by large woody debris (**W**), boulder (**B**), artificial structures (such as enhancement structure) (**A**), beaver (**V**), landslide debris (**L**), or other (**O**).

The three-letter acronym used for dam pools contains a "D" (for "Dammed") as the first letter, the position code as the second letter, and the formative feature code as the third. For example, a dammed backwater pool formed by large woody debris would have the corresponding acronym of DBW.

If "Other" is used as a formative feature, describe thoroughly in Comments (Form 5).

Scour Pools: Scour pools are formed by scour action when flowing water impinges against and is diverted by a streambank or channel obstruction (see fig. 30 for a scour pool profile). Scour pools are categorized by scour position and formative feature:

- Position:
  - Lateral Scour (**L**): The scour pool is on one side of the stream channel because the flow is directed laterally by a partial channel obstruction or shift in channel direction (fig. 31, 32, and 33).
  - Mid-Scour (**M**): The scour pool is in the middle of the channel because the flow is directed toward the middle of the channel by a partial channel obstruction (fig. 34, 35, and 36).
  - Plunge (**P**): The scour pool is formed by scouring action from vertically falling water. The scour typically is directly under the area where the plunging water meets the water below it (fig. 37 and 38).
  - Underscour (**U**): The scour pool is formed by scouring under an obstruction, such as a log. At low flow, a plunge pool may become an underscour pool (fig. 39).
- Formative Feature
  - The pool scour position is the result of large woody debris (**W**), boulder (**B**), artificial structures (**A**), bedrock (**R**), tributary (**T**), meander (**M**) (lateral scours), culvert (**C**) (mid-scour and plunge pools), beaver (**V**) (plunge pools), and other (**O**).

The three-letter acronym used for scour pools contains an "S" (for "Scour") as the first letter, the position code as the second letter, and the formative feature code as the third. For example, a lateral scour pool formed by a meander has the corresponding acronym of SLM.

If "Other" is used as a formative feature, describe thoroughly in Comments (Form 5).

Step Pool Complex (**STP**): A habitat unit characterized by a series of three or more steplike mid-scour pools separated by short turbulent water (fig. 40). The length of the turbulent water cannot exceed the average wetted width. If the stretches of the turbulent water separating the pools are longer than they are wide, both the turbulent water and pools are typed and measured separately. Step pool complexes are found in "A" and "B" reach types and typically consist of pools that are formed by boulders or bedrock. Step pool

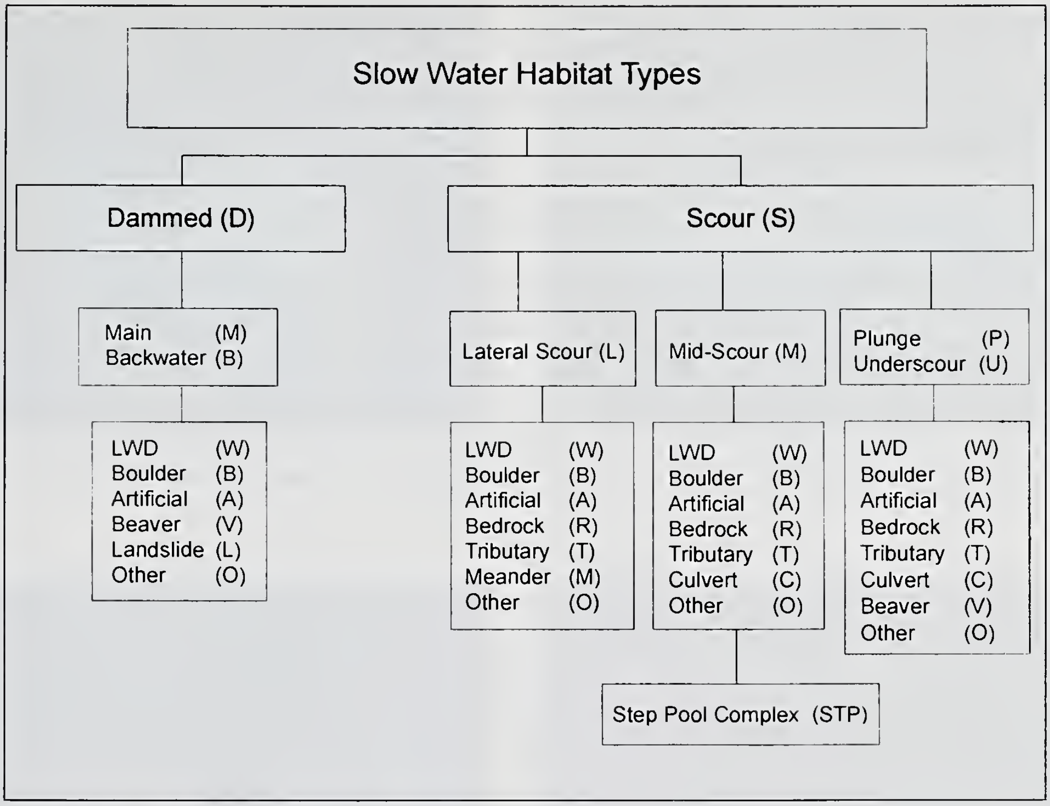


Figure 26—Slow water habitat types.

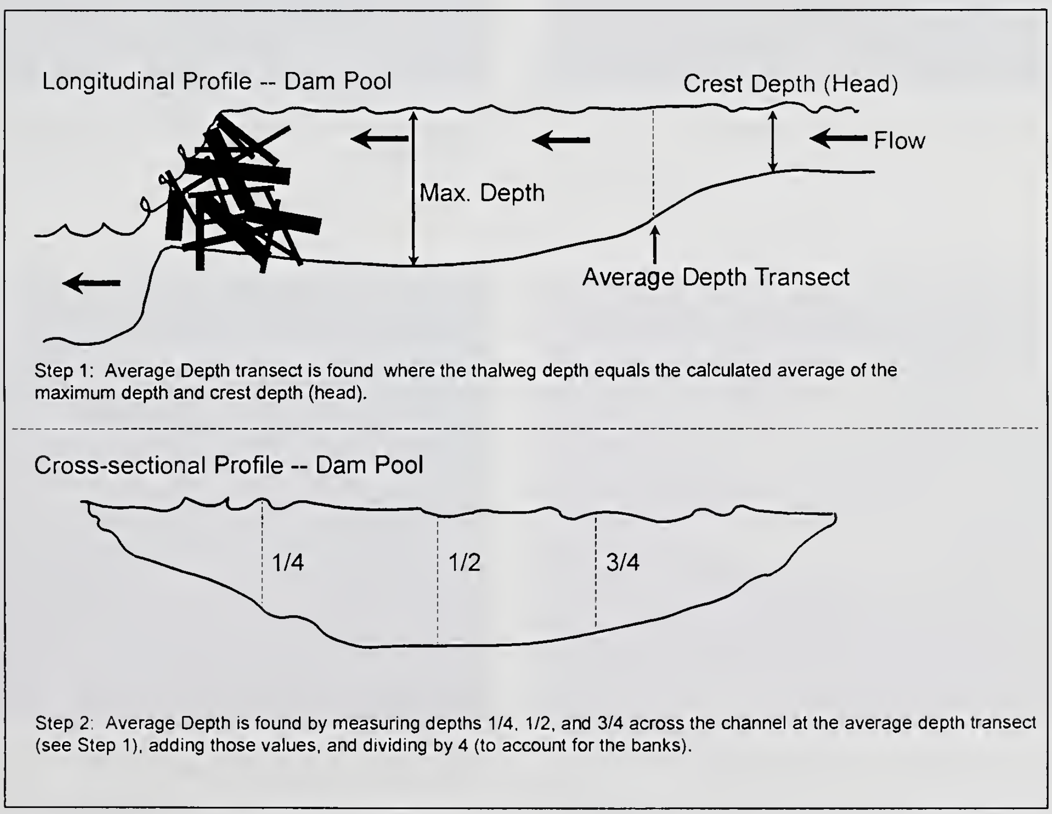


Figure 27—Calculating average depth for dam pools.

Figure 28—Dammed pool habitat type schematic.

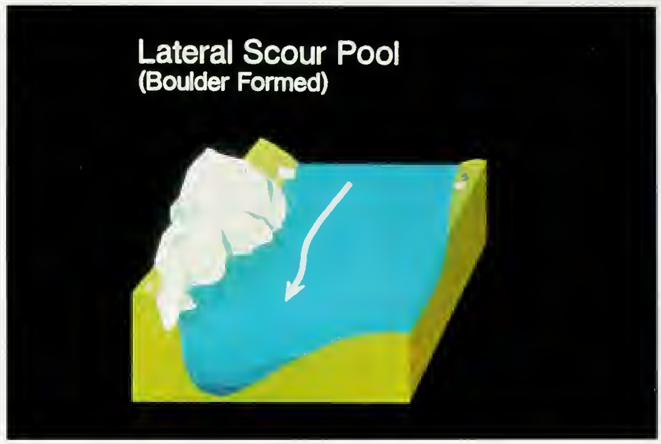
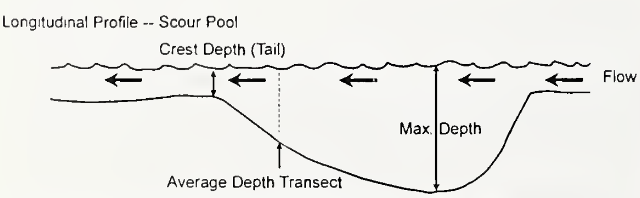


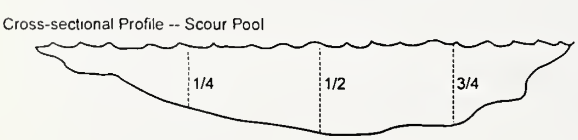
Figure 31—Lateral scour pool habitat type schematic.

Figure 29—Dammed, main channel, beaver formed (DMV).

Figure 32—Scour, lateral, large woody debris formed (SLW).



Step 1: Average depth transect is found where the thalweg depth equals the calculated average of the maximum depth and crest depth (tail).



Step 2: Average depth is found by measuring depths ¼, ½, and ¾ across the channel at the average depth transect (see Step 1), adding those values, and dividing by 4 (to account for the banks).

Figure 30—Calculating average depth for scour pools.

Figure 33—Scour, lateral, meander formed (SLM).

Figure 34—Mid-channel scour pool habitat type schematic.

Figure 37—Plunge pool habitat type schematic.

Figure 35—Scour, mid channel, boulder formed (SMB).

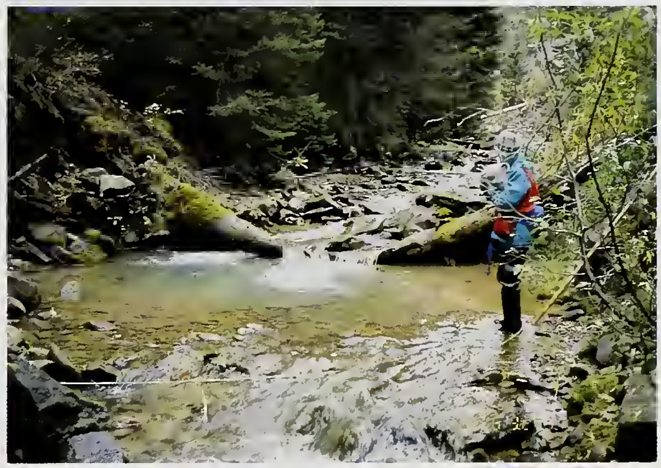


Figure 38—Scour, plunge, large woody debris formed (SPW).

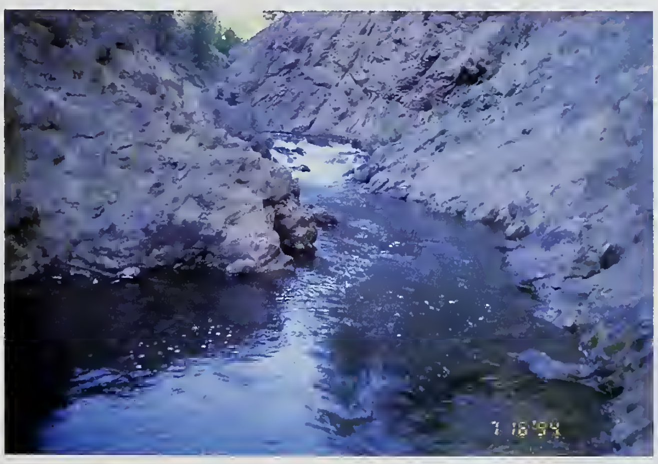


Figure 36—Scour, mid channel, bedrock formed (SMR).

Figure 39—Scour, underscour, large woody debris formed (SUW).

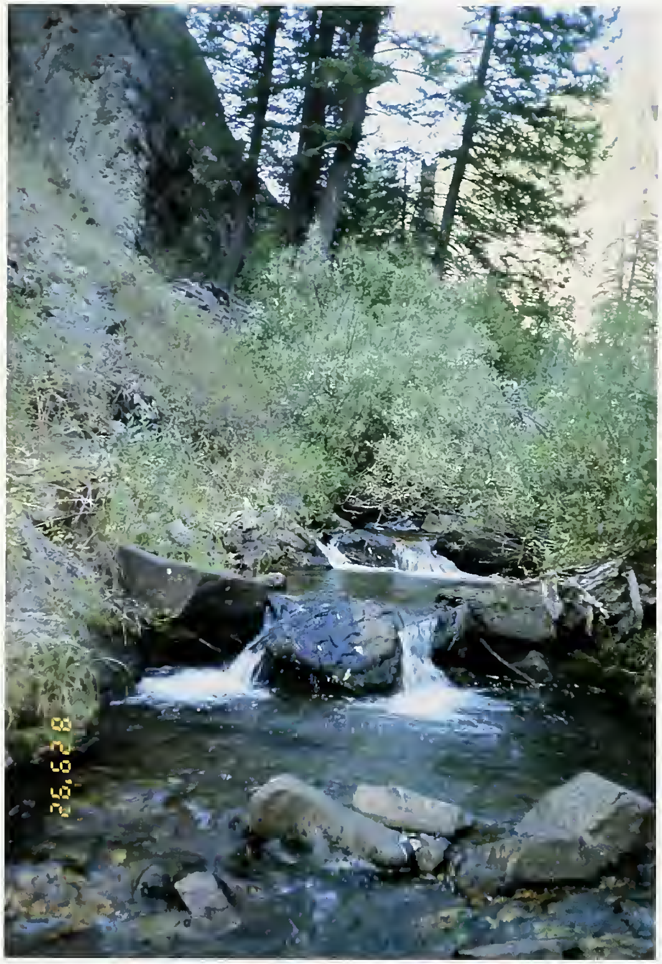


Figure 40—Step pool complex (STP).

complexes require measuring some unique variables, such as total number of pools in the complex, average maximum depth of those pools, and number of pools greater than 1 m deep. Also, other variables typically collected in pools are not collected in STP's, such as percent surface fines and crest depth (see table 6 for variables collected in STP's).

Habitat Unit Variables are dependent upon the survey reach type, the type of channel unit (in other words, main, side, or adjacent), and the habitat type. Fewer variables are collected in reaches with an "A" reach type and for side channel and adjacent units, as opposed to reaches with "B" or "C" types and main channel units. In addition, variables collected differ according to the habitat type or class (in other words, slow versus fast). Refer to table 6 to determine the variables to collect under different reach and habitat type scenarios.

Length—The length of a habitat unit is measured along the middle of the channel. First locate habitat unit boundaries, then measure upstream with a drag chain or tape measure and record to the nearest 0.1 m. If the unit is a step pool complex, measure the length of the entire complex. Length is a required measurement for all units, even if you are subsampling. If hazardous conditions prevent you from measuring the length, estimate the length, place an "E" next to the estimated length, and make a note of this in Comments (Form 5).

Average Wetted Width—Measure the average wetted width (in other words, portion of the stream that has water) across a transect (imaginary line perpendicular to flow) of the habitat unit where the width appears to be representative of the unit. Record the width to the nearest 0.1 m. Habitat units with highly variable widths should be measured at multiple locations, averaged, and recorded. Fast water habitat types that are long may also require several width measurements taken throughout the habitat unit. If the unit is a step pool complex, measure the average width of a representative step pool (in other words, not the widest nor the narrowest). Wide habitat units require a drag chain or tape measure for accurate values; narrow habitat units may be measured with a 2.0 m stadia rod to the nearest 0.1 m. If the channel is separated by a gravel or sand bar, and the habitat type is the same on both sides of the bar, measure the width of the channel and subtract the width of the bar or unwetted portion.

Average Wetted Depth—For all habitat types, use a 2.0 m stadia rod and follow directions below. A small, inexpensive solar-powered calculator is helpful for calculating average depths.

For fast water habitat types, measure the depth at one-fourth, one-half, and three-fourths of the way across the average width cross-sectional transect. Sum the three depths and divide by 4 (to compensate for "0" depth at the banks). Record the average depth to 0.01 m.

For slow water habitat types, add the pool maximum depth and pool crest depth together (see "Pool Maximum Depth" and "Pool Crest Depth" later in this section) and divide by 2 (don't record). Then find a thalweg depth equal to the calculated value. Measure the depth at one-fourth, one-half, and three-fourths of the way across at a transect located at this thalweg depth. Sum the three depths and divide by 4 (to compensate for "0" depth at the banks). For step pool complexes (STP's), measure average depth in the same pool as where the width was taken, and locate the depth transect as described above. Record the average depth to 0.01 m. See figures 27 and 30 for examples of where to calculate average depth in dammed and scour pools.

Number of Pocket Pools—Pocket pools are small (between 10 and 30 percent of wetted width), bed depressions formed around channel obstructions

Table 6—Variables collected in different reach types, channel units (in other words, main, side, and adjacent), and habitat types[a]

Variable	Reach type B,C	Reach type A	Channel unit M	Channel unit S,A	Habitat type: Fast types (except LGR)	Habitat type: Dam pools	Habitat type: STP	Habitat type: Scour pools/ LGR
Length	X	X	X	X	X	X	X	X
Width	X	X	X	X	X	X	X	X
Average depth	X	X	X	X	X	X	X	X
Fast habitat type								
Pocket pools #	X	X	X	X	X	—	—	X(LGR)
Average max-dpth	X	X	X	X	X	—	—	X(LGR)
Slow habitat type								
Max depth	X	X	X	X	—	X	X	X(Scour)
Crest depth	X	X	X	X	—	X	—	X(Scour)
Step pool #	X	X	X	X	—	—	X	—
# pools > 1 m	X	X	X	X	—	—	X	—
Average max-dpth	X	X	X	X	—	—	X	—
Surface fines %	X	X	X	X	—	—	—	X
Substrate comp	X	X	X	—	—	—	—	X
Bank lengths	X	—	X	—	X	X	X	X
Bank stability	X	—	X	—	X	X	X	X
Bank undercut	X	—	X	—	X	X	X	X
Channel shapes	X	—	X	—	X	X	X	X
Temps/time	X	X	X	—	X	X	X	X
LWD counts	X	X	X	X[b]	X	X	X	X
Riparian (RCT's)	X	X	X	—	X	X	X	X
Comments	X	X	X	X	X	X	X	X
Snorkel tally	X	—	X	X	X[c]	X	X	X
LWD (dimensions)	X	—	X	—	X	X	X	X
Fish (counts)	X	—	X	—	X[c]	X	X	X

M = Main channel units S = Side channel units A = Adjacent units X = Variable collected — = Variable not collected

[a]Variables collected depend on the combination of reach type, channel type, and habitat type (such as max depths are collected in "A" channels and in main, side, and adjacent units, but are not collected in fast habitat types); this table will determine the collected variables in a given unit.

[b]Large woody debris is counted in side channel units that are separated from the main channel by a vegetative island; large woody debris in adjacent units and in side channels separated by gravel bars is counted as part of the main channel unit (see fig. 11).

[c]Snorkeling is only conducted in those fast water units that are not so turbulent as to be dangerous or impede visibility.

(boulders, logs, irregular banks, jutting peninsulas, and so forth) within fast water habitat types only. Count and record the number of pocket pools.

Average Maximum Depth of Pocket Pools—Find the deepest part of each pocket pool with the graduated stadia rod and measure the depth. Average these depths for the average maximum depth and record to 0.01 m. If the habitat unit contains less than three pocket pools, determine the average of the maximum depths for all available pocket pools. If more than three, determine the average maximum depth from the first three pocket pools encountered.

Pool Maximum Depth—The maximum depth is collected only in slow water habitat units and represents the deepest point of a pool. It is found by probing in the pool with a 2.0 m stadia rod until the deepest spot is located. For step pool complexes, find and record the highest maximum depth out of all the pools. If a pool is too deep to measure safely (without flooding your waders), do not collect this variable. Place a dash in the appropriate space on the form or flag the habitat unit for the snorkelers to measure (if they can measure it on the same day). Record the maximum depth to the nearest 0.01 m. Also, make sure that the maximum depth is recorded as a value greater than the average depth and crest depth.

Pool Crest Depth—The crest of a slow water habitat unit is the break or transition in stream channel slope. Each slow water habitat type has both a tail crest (at the downstream end of the unit) and a head crest (at the upstream end of the unit), which represent the boundaries of that unit. Crest depth is the maximum depth at the crest. Record the tail crest depth for scour pools and head crest depth for dammed pools (fig. 27 and 30). Do not record a crest depth for step pool complexes. Be sure that the value of the crest depth is less than that of the maximum depth.

Step Pool Total—If the habitat type is a step pool complex (STP), record the total number of pools in the complex.

Number of Step Pools > 1 m Deep—If the habitat type is a step pool complex (STP), record the number of pools in the complex having maximum depths greater than 1.0 m.

Average Maximum Depth of STP Complex—If the habitat type is a step pool complex (STP), measure the maximum depth of the first three pools within the complex, calculate an average, and record.

Percent Surface Fines—Percent surface fines (particles less than 6 mm) are recorded for the wetted, flowing (not stagnant) area of scour pool tail crests (or tailouts) and low gradient riffles only (fig. 41). Surface fines data are collected in both main and side channels but not in dam or step pools. Percent surface fines can be estimated ocularly alone or estimated ocularly with a 49-intersection grid (7 inch by 7 inch metal bar grate and a 10 inch by 10 inch plexiglass viewer to break water agitation and glare). Record the method that was used (ocular or 49-intersection grid) in the header comments section (if consistent throughout the reach) or in the habitat comments (if methods varied among habitat units within a reach).

Ocular estimates are the percent of the wetted substrate area of scour pool tails and low gradient riffles (fig. 41) that is made up of fine particles (sand/silt less than 6 mm).

If you use a 49-intersection grid, calculate the percent of the wetted substrate area of scour pool tails and low gradient riffles that is made up of fine particles (sand/silt less than 6 mm) by randomly tossing the grid. After the heavy grid sinks to the bottom, hold the plexiglass over the grid to reduce glare, and count the occurrences (out of 49) where the substrate under the grid intersections is larger than 6 mm. Repeat this effort at least three times, then calculate as follows to obtain percent surface fines:

$100(1 - ((S + S + S)/49n))$ where S = number of intersections, and (n) = number of times the grid was tossed

For example, S = 40, S = 25, and S = 35 n = 3

$= 100(1 - (100/147))$
$= 100(1 - 0.68)$
$= 100(.32)$
$= 32\%$

Substrate Composition—Substrate composition is ocularly estimated or measured with a Wolman pebble count (Wolman 1954) in low gradient riffles and scour pool tails (fig. 41). Do not collect substrate composition in side channels or adjacent units. At a minimum, substrate is collected for the first main channel low gradient riffle or scour pool encountered on each page. For units in which substrate is collected, mark an "X" in the "Substrate Comp." box. This refers you to the Substrate Composition Form (Form 3). See Form 3 instructions for more details.

Bank Length—Visually estimate the total left and right bank lengths, looking upstream, for each habitat unit. The bank is along the channel margin above the scour line at the steepest angle to the water surface. The scour line occurs above the existing water level and is determined by the lower limit of sod-forming

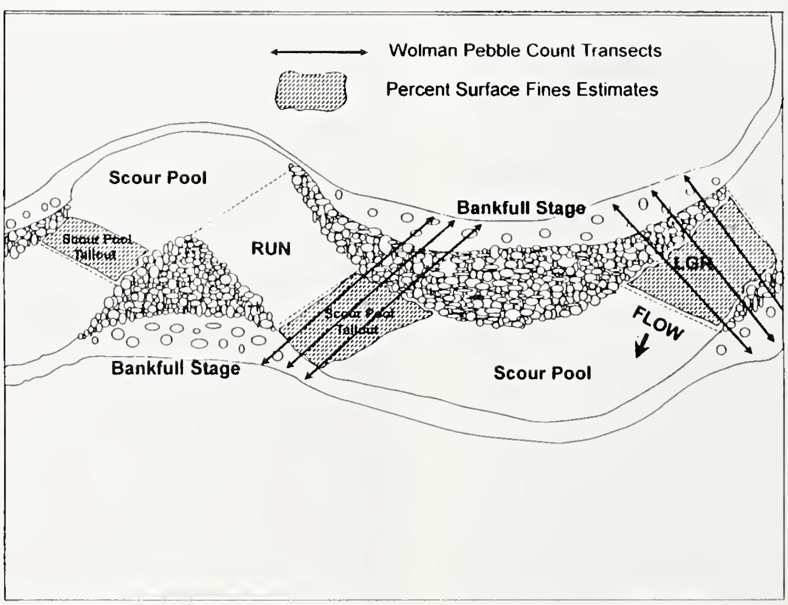


Figure 41—Locations for estimating percent surface fines and conducting Wolman pebble counts in low gradient riffles (LGR) and scour pool tailouts.

perennial vegetation, the ceiling of undercut banks, or at the boundary of any other features that provide resistance to high flows. On gravel and sand bars, the bank is at the boundary of sod-forming or perennial vegetation, or by the steepened portion of the bar just above the scour line (Bauer and Burton 1993).

Use the measured thalweg length to assist in estimating the left and right bank lengths in meters, excluding the length along the stream where tributaries enter. The left and right banks should not both be shorter than the thalweg length but may both be longer.

Bank Stability—After estimating the bank lengths, estimate the amount of stable bank for the left and right banks (looking upstream) in all habitat units. Streambanks are the steepened portion of the channel margin above the scour line. The scour line is above the current water level at the limit of perennial or sod-forming vegetation, or the ceiling of undercut banks (Bauer and Burton 1993).

A stable streambank shows no evidence of the following: **Breakdown** (clumps of bank are broken away and banks are exposed, **slumping** (banks have slipped down), **tension cracking or fracture** (a crack is visible on the bank), or **vertical and eroding** (the bank is mostly uncovered, in other words, less than 50 percent covered by perennial vegetation, roots, rocks of cobble size or larger, or logs of 0.1 m in diameter or larger, and the bank angle is steeper than 80 degrees from the horizontal) (Bauer and Burton 1993) (fig. 42). Undercut banks are considered stable unless tension fractures show on the ground surface at the back of the undercut (USDA Forest Service 1992).

Bank stability may be collected as length in meters or as a percent. Percent stable bank is easier to collect in the field and will satisfy most data collection needs. However, if monitoring is likely, length of stable bank should be collected (the supervisor must determine the appropriate method to suit the needs of the inventory). Circle the chosen method ("Length" or "Percent") on Form 2 and do not change methods within a stream. If collected as a length, the length of the stable bank cannot be greater than the total bank length. Also, you must collect the left and right bank lengths in conjunction with the stable bank estimates; otherwise, bank stability summary variables cannot be calculated using FBASE. If you subsample bank lengths, the same units should be subsampled for bank stability.

Bank length and stability are only recorded for main channel habitat units. If an island occurs that is all or mostly gravel, estimates should be made on the banks outside of the side channel (fig. 12). If a vegetated island (in other words, the majority of the island has perennial vegetation) with well-defined banks is present, estimates should be made on the island (fig. 13). For example, in figure 43, bank stability for the right bank of habitat unit 116 would be estimated for the left side of the vegetated island. For the left bank of habitat unit 116, bank stability would be estimated on the outside of side channel where the vegetated bank occurs.

Bank Undercut—Undercut banks represent that portion of the bank that is undercut at least 5 cm and is directly (within 0.1 m) over the water. Like bank stability, undercut is estimated for both banks of a

Figure 42—Unstable banks.

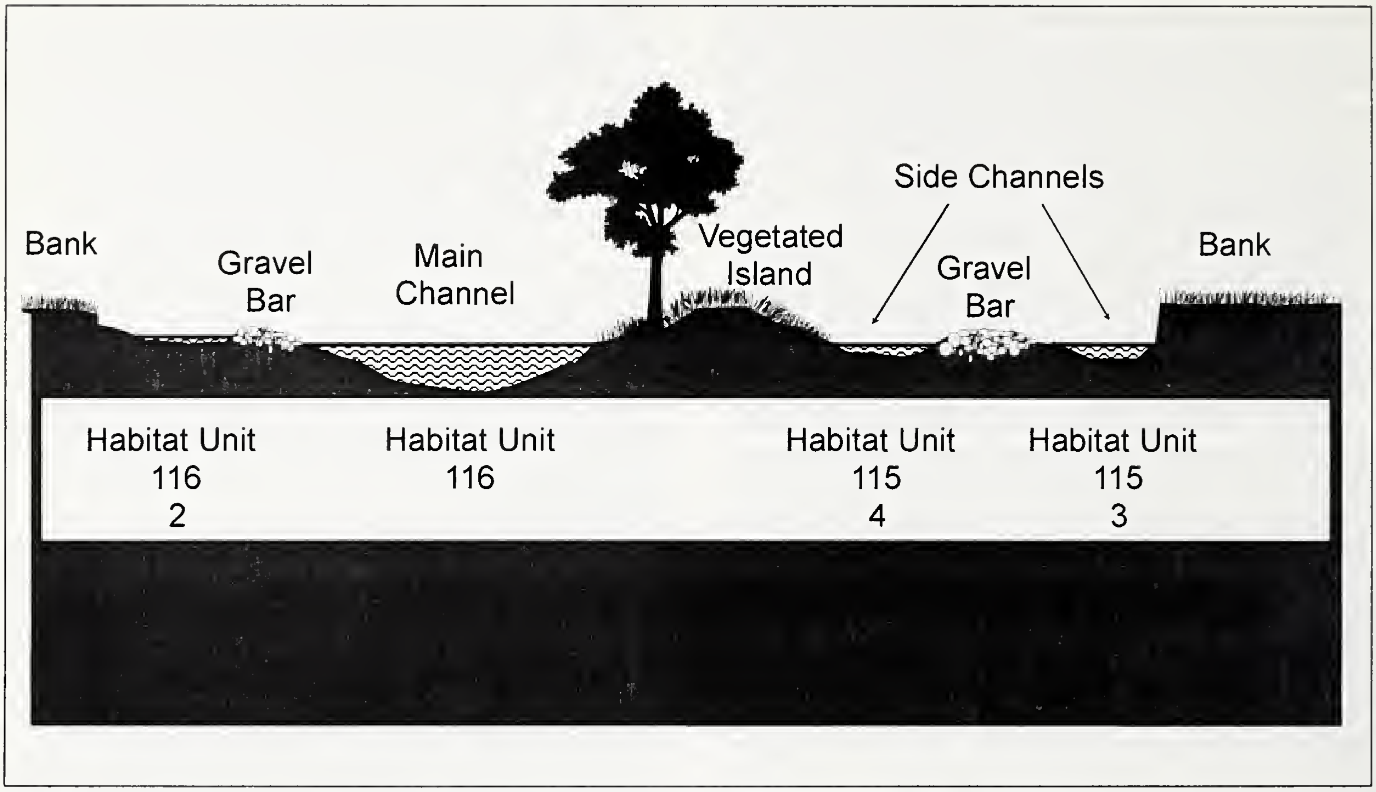


Figure 43—Cross section through the stream channel in figure 11 and its side channels, and an example of which banks are used to determine bank stability.

habitat unit and may be recorded as a length in meters or as a percentage. However, only one method can be used for a given stream. If collected as a length, the length of the undercut bank cannot be greater than the total bank length. Record the length or percentage in the appropriate spaces on Form 2. If the undercut is excessively deep (such as over 1 m), record in Comments (Form 5).

Channel Shape—Determine and record the dominant channel shape for each habitat unit on the left and right sides of the channel, looking upstream (fig. 44). The part of the channel to consider is mid-channel up to bankfull stage on each side. If greater than half of the unit on one side is undercut, the dominant channel bank shape for that side is "Z" for trapezoidal (bankfull width is less than stream bottom width). If the channel is "laid back" (bankfull width is greater than stream bottom width), the channel shape is an "I" (fig. 44) (USDA Forest Service 1992).

Water Temperature—Record the water temperature with a Celsius pocket thermometer for the first main channel habitat unit on each page, above and below tributaries, and above and below hot springs. At a minimum, collect morning, noon, and afternoon water temperatures. If appropriate, identify the reference points in Comments (Form 5).

Air Temperature—Record the air temperature with a Celsius pocket thermometer for the first habitat unit on each page and wherever water temperature is taken (see "Water Temperature").

Time of Temperature—Record the time at which the air and water temperature was taken. Express the time in military format (such as 1300).

Large Woody Debris Singles—Count the number of large woody debris singles in the unit (see description of Form 4 for definitions and criteria) and record the number on Form 2.

Large Woody Debris Aggregates—Count the number of aggregates in the unit (see description of Form 4 for definitions and criteria) and record the number on Form 2.

Large Woody Debris Rootwads—Count the number of rootwads in the unit and record the number on Form 2. Rootwads are boles or root masses attached to logs less than 3 m in length and at least 0.1 m in diameter one-third of the way up the log (fig. 45). Dead standing trees less than 3 m in height also qualify as rootwads if the root mass is visible. If a rootwad is attached to a log longer than 3 m, it qualifies as a single piece.

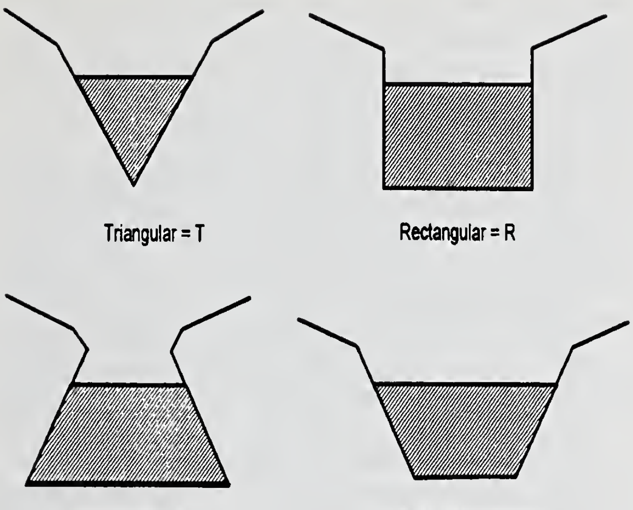


Figure 44—Channel shapes and corresponding codes.

Figure 45—Rootwad.

Riparian Community Types—For every habitat unit determine the riparian community type(s) that occurs in the riparian influence zone on the left and right side of the stream channel. The riparian influence zone is the area around the stream where vegetation is influenced by high water tables during most of the year; upland areas within 30 horizontal m of the stream channel are also considered part of the riparian influence zone.

To determine the riparian community type, use a key such as that used by the Nez Perce National Forest (Green 1991) (appendix E) or a published riparian guide such as "Riparian Community Type Classification of Eastern Idaho - Western Wyoming" (Youngblood and others 1985). A number of available guides cover Regions 1 and 4, including the "Integrated Riparian Evaluation Guide: Intermountain Region" (USDA Forest Service 1992) and "Classification and Management of Montana's Riparian and Wetland Sites" (Hansen and others 1995). Use these guides to assist in community typing but not for methods of data collection since they deviate from those used in this inventory (unless, of course, you are conducting a separate riparian inventory). The biologist leading the inventory should choose the most appropriate classification guide that will accommodate the level of detail desired.

All guides available contain a code that represents the riparian community type. For instance, in the Nez Perce National Forest guide, the riparian community type codes are represented by three characters that describe the general community type (such as CM1 represents an "Upland Grand Fir/Cedar community with midshrub/forb understory;" appendix E). In the species-specific guides such as the Eastern Idaho - Western Wyoming guide and the Montana guide, the code represents the first two letters of the genus name followed by the first two letters of the species name, and the different species making up the riparian community type are separated by a slash. For example, a *Salix wolfii* / *Carex rostrata* riparian community type has the code SAWO/CARO. Regardless of the key used to describe the community types, it is important to remain consistent in the classification of those types by using only one well-documented guide for all reaches and, preferably, all streams.

If only one riparian community type occurs in the riparian influence zone of one bank, record the riparian community type code on Form 2 in the space for "RCT1." If more than one riparian community type is present on one bank, put the code of the dominant riparian community type (in other words, most prevalent in terms of percentage of occupied area) in the space for "RCT1" and the subdominant riparian community type in the space for "RCT2." In some cases the true riparian area is narrow and upland vegetation occurs within 30 m of the stream channel. In this situation, identify the riparian community type for the upland area and the riparian area and record one as dominant and the other as subdominant. If the riparian community type occupies less than 15 percent of the riparian zone or does not fall out as the dominant or subdominant riparian community type, do not include it on Form 2; however, describe it in Form 5 (Comments). Often the riparian community type remains the same for several habitat units or even the reach. If this is the case, draw a line through the spaces meant for the codes until a new riparian community type is encountered. Do not leave the spaces blank because a blank could be misinterpreted as missing data. All missing data should be marked with a dash to avoid confusion.

Pictures of the riparian influence zone should be taken at least once for every 10 habitat units. The habitat unit number, roll number, exposure number, and short description should be recorded on Form 5 under "PHOTOGRAPHS." Also, make note if the picture was taken looking upstream or downstream.

Comments—If comments or photographs for the habitat unit are warranted, place an "X" on the habitat form and record any habitat unit-specific comments on Form 5. See Form 5 instructions for more details on recording comments.

Snorkel Tally—Use this space to tally the occurrence of each habitat type. The first unit of a particular habitat type and every fifth unit of that type thereafter is snorkeled. Place an "X" in the snorkel tally row to represent a snorkel unit. Other units are numbered consecutively from 1 to 4. For example, the first low gradient riffle encountered in the reach receives an "X" for a snorkel unit, the second gets a "2," and so forth, up through "4." The fifth unit is "X"ed for a snorkel unit. The next low gradient riffle receives a "1," and the numbering sequence starts over. Snorkel units are flagged (see description below). Note: This is the suggested sampling frequency for snorkeling; however, it may be modified according to the needs of the individual Forest or District. Exclude side channel and adjacent units from this tally unless the supervisor wants those units to be snorkeled. If snorkeling is not to be conducted on this reach or stream, leave this space blank.

Habitat units should be flagged thoroughly to assure that snorkel crews can find these units easily and consistently (in other words, same height above the water, same length of flagging, same color of flagging, same side of stream, and so forth). Flag both the upper and lower ends of the selected habitat unit. Flag as close to the habitat unit breaks as possible. Write the following information on all flags: inventory date, habitat unit number, habitat type, and flag location (UPPER or LOWER). Permanent ink pens (such as medium point Sharpies) should be used to record information on the flags.

Other Variables (Optional)—Although the following variables are not on the data forms, they can be entered into the database and therefore can be collected if desired. These variables cannot be entered directly into FBASE, but they can be entered into FBASE files through other database programs such as dBase IV, Paradox, or Access (except for Physical Variables 1 and 2, which can be entered directly into FBASE screens). If any of these variables are collected, record the data on the back of the habitat form or on a separate piece of paper (be sure to also record the habitat unit) and make a comment in the header form that describes the additional habitat variables collected (such as "Physical Variable 1 is a pool quality rating for all pools and Physical Variable 2 is percent cobble embeddedness for scour pools"). The following additional variables may be collected:

- **Habitat Unit Latitude and Longitude**: These data are obtained using a global positioning system unit for individual habitat unit locations.
- **Bankfull Width and Depth**: These variables may be collected at a reduced frequency (in other words, subsampled) to calibrate the observer's eye for bankfull stage, aid in Rosgen stream typing, obtain basic hydrology data such as bankfull discharge, or monitor channel changes over time.
- **Physical Variables 1 and 2**: The FBASE program allows one character (Physical Variable 1) and one numeric (Physical Variable 2) habitat variable to be entered that is not part of the standard protocol. This allows the flexibility to collect a desired habitat (unit-level) variable(s), such as pool quality rating (character) or cobble embeddedness (numeric), that is not contained on the data form. If the option to collect these "blank" variables is chosen, the data are collected in the field and later can be entered in the FBASE program.
- **Riparian Variable 1**: The FBASE program allows one character (not numeric) variable to be entered pertaining to the riparian community types that is not included in the standard protocol. For instance, if dominant species is a desired variable, the data are collected in the field and can then be entered into the database.

Form 3: Substrate Composition

The variables collected (and data form abbreviations) on Form 3 are:

Stream
Survey Reach Number (Reach #)
Date
Page
Habitat Unit Number (Hab Unit #)
Method
Substrate classes (Fines <2 mm, Small Gravel 2-8 mm, Gravel 8-64 mm, Small Cobble 64-128 mm, Cobble 128-256 mm, Small Boulder 256-512 mm, Boulder >512 mm, and Bedrock)

Identification of the variables is as follows:

Stream—Record the stream name as it appears on the header form. Record this information on each page in case the data forms get separated.

Survey Reach Number—Record the survey reach number (in other words, 1, 2, 3...).

Date—Record the date (MM/DD/YY) on which the substrate data are collected.

Page—Record the sequential page number of each substrate composition form used for the reach.

Habitat Unit Number—Record the habitat unit number for which the substrate data are being collected. Substrate composition inventories are conducted only in scour pool tails (except in STP types) and low gradient riffles (fig. 41). Substrate composition data should be collected at the first main channel low gradient riffle or scour pool tail encountered on each page. Substrate data are not collected in side channel or adjacent units.

Method—Record the method used for substrate composition: an "EST" if the ocular method is used or "WPC" if a measured Wolman Pebble Count is conducted (Wolman 1954). The Wolman Pebble Count and ocular estimate procedures are described below.

Substrate Classes—The substrate classes are based on the Wentworth Scale and modified from Lane (1947) (table 7). Two methods, the ocular estimate or the Wolman Pebble Count (Wolman 1954), may be used to determine the amount of each substrate class within the stream channel. The two methods are described as follows:

A Wolman Pebble Count may be conducted if a measurement of substrate is preferred, or it may be used as a training tool to calibrate the observer's eyes to the proper size categories.

To conduct this count, visually locate a transect perpendicular to the stream in the scour pool tailout or low gradient riffle. Starting at the bankfull stage mark (see bankfull explanation below), step across the transect and pick up (or feel if the substrate is too large to lift) the first particle your fingertip encounters when placed in front of your boot. Look forward at the opposite bank, so as not to bias the choice. Measure the intermediate axis of the sampled particle. The intermediate axis is neither the longest nor the shortest of three mutually perpendicular axes of a particle.

Table 7—Size classes used to characterize substrate composition. Based on the Wentworth scale and modified from Lane (1947).

Substrate class	Size classes (mm)
Fines	<2
Small gravel	2-8
Gravel	8-64
Small cobble	64-128
Cobble	128-256
Small boulder	256-512
Boulder	>512
Bedrock	Solid rock

Measure each intermediate axis with a plastic ruler and record the count of particles falling within the size classes (table 7) on Form 3. Deposit the particle downstream. When you reach the bankfull stage at the opposite bank, turn around and locate another transect upstream one or two steps from the first transect. Continue traversing transects until 100 particles have been measured. If at this point you have not completed a transect, continue to measure particles until you finish the transect. You need at least 100 particles, though a larger sample is acceptable. If a layer of silt (suspended sediment) coats the substrate, measure the larger particle upon which it lies and make a comment in the Comments (Form 5) explaining such. A simple way to test if the sediment is not bedload is to wave a hand over it and see if it becomes suspended.

When recording the data, use the dot method (10) or hash marks (5) to keep track of the counts. When finished with the Wolman Pebble Count for the unit, count the tally marks and put the final count in the box provided in the lower right corner (place a "0" in the box if the substrate class had no counts) (see appendix B for an example).

Ocular estimate is the estimate of the percentage of each substrate class (table 7) through visual observation. The area you should observe is the tailout area of the pool or the entire low gradient riffle, from bankfull stage to bankfull stage (see explanation of bankfull stage below). Record the percentage of each substrate class observed in the boxes provided on Form 3. If the class was not observed, record a "0" for that class. The estimated substrate percentages should total 100 for each habitat unit.

As indicated above, the technique for conducting a Wolman Pebble Count and an ocular estimate of substrate composition requires knowledge of how to locate the bankfull stage of the unit. The following explanation of bankfull stage and indicators is taken from the video "A Guide to Field Identification of Bankfull Stages in the Western United States" (USDA Forest Service 1995). We suggest that field units obtain and refer to this video for further information. See References section for contact information.

Bankfull stage is the stage at which water starts to flow over the floodplain. A floodplain is defined as a relatively flat depositional feature (surface) adjacent to the river that is formed by the river under current climatic and hydrologic conditions. Bankfull stage can be determined by using regional curves and gauging station data, selecting and measuring a representative reach, or using bankfull indicators in the field. Generally, our procedures use field bankfull indicators to find bankfull stage, although regional curves and gauging stations may be used if the data are available for that specific watershed or one similar in drainage area.

Look for the following field bankfull indicators to determine bankfull stage: (1) presence and height of depositional features; specifically, look for flat depositional areas such as point bars; (2) slope of the bank or break in slope of the bank; specifically, look for the transition between horizontal depositional areas and the vertical bank; and (3) vegetative indicators, especially the lower limits of certain perennial species such as alder. Use all of these indicators together to verify bankfull stage.

Also, look upstream and downstream to get a feel for bankfull elevation. If bankfull stage is too difficult to determine in a unit, postpone taking substrate composition until the next appropriate unit, and make a comment on the comment form as to why substrate composition was not collected in that unit.

Form 4: Large Woody Debris ("B" and "C" Reach Types)

The variables collected (and data form abbreviations) on Form 4 are:

Stream
Survey Reach Number (Reach #)
Date
Page
Habitat Unit Number (Hab Unit #)
Single Pieces—Length and Diameter (Ln X Dia)
Single Pieces—Percent Submerged (% Submg.)
Aggregates—Number of Pieces (# Pcs.)
Other Variables [Optional]:

Identification of the variables is as follows:

Stream—Record the stream name as it appears on the header form. Record this information on each page in case the data forms get separated.

Survey Reach Number—Record the survey reach number (in other words, 1, 2, 3...).

Date—Record the date (MM/DD/YY) on which the large woody debris data are collected.

Page—Record the sequential page number of each large woody debris form used for the reach.

Habitat Unit Number—Record the habitat unit number for which the large woody debris data are collected. Large woody debris dimensions (in other words, lengths and diameters of singles and number of pieces for aggregates) are collected only for survey reaches with "B" and "C" reach types. For survey reaches with an "A" reach type, large woody debris data only are counted (Form 2). All large woody debris encountered in side channel habitat units that are separated by unvegetated gravel bar islands (in other words, the majority of the island does not consist of perennial vegetation) is considered as part of the main channel habitat unit (fig. 12). Thus, both counts and dimensions are collected, and the habitat unit number recorded on the large woody debris form is the main channel unit into which the side channel flows. Large woody debris encountered in side channel habitat units separated by a vegetated island (in other words, the majority of the island has perennial vegetation) should be counted only and recorded for the side channel unit on Form 2 (fig. 13). For example, in figure 11, large woody debris counts and dimensions for main channel unit 116, adjacent unit 116-1, and side channel unit 116-2 are collected and recorded for habitat unit 116. In side channel unit 115-2, large woody debris counts are collected and recorded for the side channel unit because it is separated by a vegetated island.

Single Pieces—Length and Diameter—All large woody debris that is within the bankfull channel is considered. Include "spanners" (single pieces of large woody debris that span the width of the stream but are located above the water) if they would potentially be in the water or at the surface at bankfull flow.

For length, ocularly estimate or measure with a stadia rod the length of every large woody debris single piece in the habitat unit. To qualify, a single piece must be at least 3 m in length or must have a length equal to or greater than two-thirds the wetted width of the stream and must fit the diameter requirements (see below). Dead standing trees that meet these criteria are also considered as single pieces. At least five lengths should be ocularly estimated and then measured with the stadia rod each day to keep your eyes calibrated. For single pieces that are measured for calibration purposes, record the measured rather than the estimated lengths. Record the length of each single on the left side of the "Ln x Dia" block.

For diameter, ocularly estimate or measure with a stadia rod the diameter of every large woody debris single piece in the habitat unit. To qualify, a single piece must be at least 0.1 m in diameter one-third of the way up from the base and must satisfy the length requirement (see above). At least five diameters should be ocularly estimated and then measured with the stadia rod each day to keep your eyes calibrated. For singles that are measured for calibration purposes, record the measured rather than the estimated diameters. Record the diameter of each single on the right side of the "Ln x Dia" block (separate the length and diameter with an "x" (such as 5.5 x 0.20).

Single Pieces—Percent Submerged—For each single piece, estimate and record the percentage (by volume) that is submerged at the time of the inventory. Record a "0" if no part of the single piece is submerged.

Notice on Form 4 that there are two columns in which to enter the dimensions and percent submerged of single pieces. Work across these columns rather than down so that the data are grouped with the habitat unit (for instance, if there were two singles for habitat unit 1, the dimensions and percent submerged would be recorded on the top row for both pieces).

Aggregates—Number of Pieces—An aggregate represents two or more clumped (in other words, touching) pieces of large woody debris each of which qualifies as a single piece (see above). Count or estimate (if difficult to count) the number of all qualifying pieces within each aggregate. Do not record number of pieces as 10+ or 100+. In some cases, beaver dams and other significant woody debris groups have no qualifying pieces. In these cases, write a comment to this effect and take a photograph (see Form 5, Comments).

Notice on Form 4 that there are two columns in which to record number of pieces in the aggregate. Work across these columns so that data for a given habitat unit are grouped together.

Other Variables (Optional)—For LWD Variable 1, the FBASE database program allows one large woody debris numeric (not character) variable to be entered that is not included in the standard protocol. For instance, if number of small wood pieces is a desired variable, the data are collected in the field and can then be entered into the database. Record these data on the back of the large woody debris form or on a separate piece of paper (be sure to also record the habitat unit) and make a comment in the header form as to what the data refer to (such as "LWD variable is a count of small wood pieces that don't qualify as singles").

Form 5: Comments

The variables collected (and data form abbreviations) on Form 5 are:

Stream
Survey Reach Number (Reach #)
Date
Page
Habitat Unit Number (Hab. #)
Comments
Photographs—Habitat Unit Number (Hab. #), Roll Number (R#), Exposure Number (EX#), and Description

Identification of the variables is as follows:

Stream—Record the stream name as it appears on the header form. Record this information on each page in case the data forms get separated.

Survey Reach Number—Record the survey reach number (in other words, 1, 2, 3...).

Date—Record the date (MM/DD/YY) on which the comments are recorded.

Page—Record the sequential page number of each comments form used for the reach.

Habitat Unit Number—Record the habitat unit number to which the comments pertain.

Comments—Comments are recorded when "Comments" is "X"ed on Form 2 or 6. Circle "Habitat" or "Fish" on Form 5 to identify whether the comments pertain to the habitat data or snorkel data. Record outstanding permanent landmarks, tributaries (bank from which the tributary enters and approximate distance of entry point upstream from the bottom of the habitat unit), bridges, roads and trails, landslides, management activities (grazing, logging, mining, and so forth), irrigation diversions, migration barriers, and so forth. In fish comments, specify any nongame fish seen (such as "Adult whitefish observed"). Include in your comments anything that will assist future crews in finding locations common to your inventory. If a side channel exists, record the approximate distance from the beginning of the main channel habitat unit to where the side channel converges. Also, be sure to note which bank (right or left), looking upstream, the side channel converges from or the adjacent habitat unit is connected to. Comments should be concise, professional, legible, and void of slang and jargon. See below for recommended abbreviations (also see appendix B for examples of appropriate comments).

Photographs—Color slides (recommended) or prints should be taken of the stream looking upstream and downstream from survey reach boundaries and of the riparian influence zones every 10th habitat unit. Also take pictures of unique features (landslides, management activities, unusual habitat types, and so forth). For each photo taken, write the corresponding habitat unit number ("Hab. #"), the film roll number ("R#"), and the exposure number ("EX#"), as well as a short description of what the photo represents. In the description, use abbreviations as much as possible and note whether the photo was taken looking upstream or downstream, and note side of the stream it represents. If more room is needed, continue on the back of the paper or another form. The following are some abbreviations to use when recording comments or photograph descriptions:

LB = Left bank
RB = Right bank
LWD = Large woody debris
HU# = Habitat unit number
HAB = Habitat
SM = Scour mark
BOU = Bottom of unit
MU = Mid-unit

TOU = Top of unit
MC = Main channel
SC = Side channel
ADJ = Adjacent
DS = Downstream
US = Upstream
WPC = Wolman pebble count
EST = Estimated
TRIB = Tributary
RCT = Riparian community type

Form 6: Fish Population Sampling

The R1/R4 Fish Habitat Inventory procedures incorporate direct enumeration techniques discussed by Thurow (1994) to count the total number of fish within a given habitat unit. Typically, either one or two observers count all fish in a single pass. This method assumes the counts of fish are accurate.

In smaller streams with excellent visibility, the snorkeler counts all fish in the entire habitat unit or that portion of the habitat unit that is snorkeled. This is done using one of three approaches depending on the characteristics of the habitat unit:

1. The snorkeler may proceed up the center of the habitat unit and count fish by zigzagging outward to both banks. Care should be taken to search for fish throughout the habitat unit, including the margins, and to inspect all cover components (such as undercut banks, substrate, and organic debris).
2. If the water is too deep or turbulent to zigzag and visibility is adequate, the observer moves up one bank of the habitat unit and counts all fish to the other bank.
3. In water too deep to count upstream, the observer floats down the center of the habitat unit and counts all fish from bank to bank, remaining as motionless as possible.

Although water clarity may allow one observer to see across the width of the channel, another snorkeler may be needed to count fish concealed by visual obstructions such as boulders, ledges, and organic debris if all fish are to be counted in a single pass. Shallow and wide habitat units typically require more observers than narrow, deep-water habitat units.

If two snorkelers are used, the habitat unit is divided in half where feasible, and snorkelers use one of three techniques:

1. Snorkelers begin in the center of the habitat unit, move upstream shoulder to shoulder, and count all fish looking outward between themselves and the bank.
2. If the habitat unit is too deep or turbulent to allow that approach, snorkelers may use natural breaks and features, such as boulders, to divide the habitat unit in half and count all fish in their portion of the habitat unit.
3. In water too deep to move upstream, two snorkelers lock hands and float down the center of the habitat unit remaining as motionless as possible, counting all fish looking outward from their shoulder to the bank.

To avoid recounting fish, observers should stay adjacent to each other, move at the same speed, and only count fish that pass them. It is also important that both snorkelers understand the underwater hand signals. For example, when a fish darts between both snorkelers, hand communications should clearly portray who will count the fish.

The following sampling criteria used for snorkeling should be strictly adhered to. If not, comments in regard to these four criteria should be recorded so data can be used accordingly.

- Timing: Snorkeling should occur between the stabilization of streamflows in late June or July to the onset of cooler water temperatures in September.
- Lighting: Snorkeling should occur when the sun is directly overhead between late morning and early afternoon.
- Minimum Temperature: Snorkeling should be conducted when water temperatures exceed 9 °C.
- Water Clarity: Snorkeling should occur when visibility is greater than 3 to 4 m. At minimum, snorkeling should not occur in habitat units with visibility less than the maximum depth of the habitat unit.

The variables collected (and data form abbreviations) on Form 6 are:

Stream
Survey Reach Number (Reach #)
Date
Page
Diver1
Diver2
Habitat Unit Number (Habitat Unit #)
Habitat Type
Habitat Length
Distance Between Habitat Units (Dist. Betw. Units)
Dive Date
Dive Water Temperature (Dive Water Temp)
Dive Air Temperature (Dive Air Temp)
Dive Time
Dive Length
Dive Average Width (Dive Avg. Width)
Dive Average Depth (Dive Avg. Depth)
Dive Maximum Depth (Dive Max Depth)
Percent Undercut Bank (% Undercut Bank)
Percent Overhead Cover (% Overhead Cover)
Percent Submerged Cover (% Submerged Cover)
Percent Large Substrate (% Large Substrate)

Fish Counts (CHIN 0 (50-80), CHIN 1 (> 100), Adult Chinook, ST1 (70-130), ST2 (130-200), ST3 (200-250), RB > 250, RD < 100, RD 100-200, RD > 200, CT < 100, CT 100-200, CT 200-300, CT > 300, BT < 100, BT 100-200, BT 200-300, BT 300-400, BT 400-500, BT > 500, BK < 100, BK 100-200, BK 200-300, BK > 300, BN < 100, BN 100-200, BN 200-300, BN 300-400, BN > 400, YOY < 70, No Fish
Comments
Other Variables [Optional]

Stream—Record the stream name as it appears on the header form. Record this information on each page in case the data forms get separated.

Survey Reach Number—Record the survey reach number (in other words, 1, 2, 3...).

Date—Record the date (MM/DD/YY) on which the snorkeling takes place.

Page—Record the sequential page number of each fish data form used for the reach.

Diver1—Record the name of diver #1 in the following format: J.COUSTEAU for Jacques Cousteau. Diver1 should remain the same throughout the reach.

Diver2—Record the name of diver #2 in the following format: I.SUCKER for Ima Sucker. Diver2 should remain the same throughout the reach.

Habitat Unit Number—Record the habitat unit number that is "X"ed on Form 2 (copy from Form 2 prior to snorkeling).

Habitat Type—Record the habitat type acronym that corresponds to the above habitat unit number (copy from Form 2 prior to snorkeling).

Habitat Length—Record the length of the habitat unit that corresponds to the above habitat unit (copy from Form 2 prior to snorkeling).

Distance Between Habitat Units—Calculate the distance between flagged ("X"ed) habitat units from Form 2 in the office, prior to snorkeling. This measurement helps the snorkeling crews locate the habitat units for snorkeling. It is also helpful if the snorkel crew reviews Form 5 (Comments) for identifiable landmarks (in other words, bridges, fences, upstream and downstream habitat types, and so forth) to assist them in finding the flagged habitat unit.

Dive Date—Record the date (MM/DD/YY) when the habitat unit is snorkeled.

Dive Water Temperature—Measure the water temperature with a Celsius pocket thermometer at the time the habitat unit is snorkeled and record.

Dive Air Temperature—Measure the air temperature with a Celsius pocket thermometer at the time the habitat unit is snorkeled and record.

Dive Time—Record the time (in military format) at which the habitat unit is snorkeled.

After snorkeling a given habitat unit, snorkelers should remeasure all habitat unit variables and record on Form 6 (Fish Data). Do not simply transfer these variables from Form 2 (Habitat Inventory) because flow conditions may have changed considerably during the time lag between the habitat inventory and the snorkeling. Also, the measurements made by the snorkel crews are more intensive.

Dive Length—Measure the length of the center line of each snorkeled habitat unit or the portion of the habitat unit snorkeled. In fast water habitat units that are longer than 50 m, snorkel the first 50 m.

Dive Average Width—Measure the width at three equally spaced intervals (one-fourth, one-half, and three-fourths up the habitat unit) perpendicular to the center line and average.

Dive Average Depth—Measure the depth at points one-fourth, one-half, and three-fourths across each of the three average width transects. Sum these nine measurements and divide by 12 to compensate for the "0" depths at the banks. This should be done for both slow water and fast water habitat units.

Dive Maximum Depth—Measure the deepest point only in slow water habitat units.

Percent Undercut Bank—Estimate and record to the nearest 10 percent the amount of undercut bank relative to the total surface area of the habitat unit. Undercut banks are that portion of the bank that is undercut at least 5 cm and is directly over the water (within 0.1 m).

Percent Overhead Cover—Estimate and record to the nearest 10 percent the amount of overhead cover relative to the total surface area of the habitat unit. Overhead cover includes the following objects that are touching or are within 0.3 m of the water surface: bank vegetation, tree branches, floating logs, debris, surface turbulence, and white water.

Percent Submerged Cover—Estimate and record to the nearest 10 percent the amount of submerged cover relative to the total surface area of the habitat unit. Submerged cover includes large woody debris, other organic debris, submerged ledges, and aquatic vegetation.

Percent Large Substrate—Estimate and record to the nearest 10 percent the amount of large substrate relative to the total surface area of the habitat unit.

Large substrate includes cobble and boulders that provide velocity breaks for fish.

The total of the four cover classes may exceed 100 percent.

Fish Counts—Fish are counted by species and size or age classes depending on the species. Counts are recorded on a polyvinyl chloride cuff or slate and later transferred to Form 6 (Fish Data). Count fish to the best of your ability; do not record as 10+ or 100+. Total counts for chinook salmon and steelhead trout are made by age classes. Total counts for large resident rainbow trout, redband trout, cutthroat trout, bull trout, brook trout, and brown trout are made by size classes; see Form 6 (Fish Data) for age and size classes. Presence of young-of-the-year trout is denoted as a "+." If no fish are seen in the unit, put an "X" in the "No Fish" box. Any fish species seen that are not listed on the form, including all nongame fish, should be specified in Comments (Form 5).

Comments—If comments are warranted, place an "X" on Form 6, circle "Fish" at the top of Form 5, and provide the comments or photograph description. Nongame species such as mountain whitefish, sucker spp., northern squawfish, redside shiners, dace, sculpins, and tailed frogs that are seen should be recorded in the comments (such as, "2 sculpins observed"), as well as any other fish or amphibians observed that are not listed on the form.

Other Variables (Optional)—For Fish Variable 1, the FBASE program allows a numeric (not character) fish variable to be entered that is not included in the standard protocol. For instance, if number of tailed frogs observed is a desired variable, the data are collected in the field and later entered into the database. Record these data on the back of the fish form or on a separate piece of paper (be sure to also record the habitat unit) and make a comment in the header form as to what the data refer to (such as, "Fish Variable refers to the number of tailed frogs observed in the snorkel unit").

Mandatory: Safety Must be Given Highest Priority—Snorkelers should always have a partner, either on shore or in the water. Never attach ropes or survey tapes to a snorkeler. Assess hazards of the site before entering the water. Avoid areas of extreme water velocity and turbulence, especially those immediately upstream from debris jams or bedrock outcrops. If it becomes necessary to survey turbulent habitat units, attempt to complete surveys from the channel margins and avoid entering the most turbulent locations. Use extreme caution when snorkeling under and within debris jams to avoid entrapment. While wading, avoid walking in areas of large boulders to prevent foot entrapment or pinching. When floating downstream head first in turbulent water, place one hand in front of your mask to protect against hitting a boulder with your mask. Stay alert for rattlesnakes because they often live in riparian zones. Recognize the symptoms of hypothermia and know how to treat it. Use swimmer's ear medication every night after snorkeling if you are susceptible to ear infections. All crew members must complete cardiopulmonary resuscitation (CPR) and first aid training. Carry a first aid kit that includes a cardiopulmonary resuscitation mask and a device for extracting poison. For greater detail on snorkeling procedures, see "Underwater Methods for Study of Salmonids in the Intermountain West," Thurow (1994).

III. Inventory Training

The quality of the inventory data is only as good as the skills of the crew collecting the data. The following four-step process of training and quality control measures has been developed to improve such skills. These measures are designed to allow adequate time for learning, not to overwhelm crews with numerous definitions and techniques .

Preinventory Training

Preinventory training should be limited to 12 or fewer participants and usually can be completed in 1 day. This training involves the following:

1. Distribute this handbook to all crew members to read. Crews should be given plenty of time between the preinventory training and inventory training to read these procedures. This should give the crews a brief introduction into the procedures and terminology that will be discussed during the inventory training.
2. Describe each of the levels of the four-step inventory process and how these steps relate to each other and to data processing with FBASE. Emphasize the teamwork required to complete these steps.
3. Demonstrate proper techniques to complete preparatory office steps required in the preinventory process. This should include exercises on reading topographic maps, calculating stream map gradients, determining Environmental Protection Agency reach numbers, determining Administering Forest, and so forth. Also show the video "A Guide to Field Identification of Bankfull Stage in the Western United States" (USDA Forest Service 1995; see References section for contact information).
4. Divide participants into small crews. Complete the header forms for a common stream and go over as a group.
5. Describe the necessary equipment (or options thereof) to complete the inventory and the proper use and care of such equipment.

Inventory Training

Inventory training should be limited to 12 or less participants and usually requires a day and a half to complete. This training involves the following:

1. Demonstrate proper techniques for collecting variables and recording data on the appropriate forms. We have found reviewing a previously inventoried stream segment, accompanied with completed inventory forms for all participants, to be an effective way to demonstrate these techniques. During such a review, participants can follow the discussion and demonstrations rather than concentrating on where particular measurements are recorded.
2. Give crews the opportunity to practice these procedures on a common stream with a leader who can answer questions. When all the crews have completed a short inventory, go back and each person individually review each habitat unit in an interactive way so that crew members can learn from each other. Crews should be asked to explain why they made a particular call or how they came up with a particular measurement.
3. Take crews to locations that are appropriate to discuss variables that are giving crews trouble, rather than trying to verbally describe or draw these variables. For example, show crews first hand the difference between unconfined, moderately confined, and confined channels, the difference between "A," "B," and "C" reach types, and so forth.
4. End the inventory training with instructions and locations for the next step, which is unsupervised practice and supervised review. We suggest that a practice stream segment be selected that is representative of what crews will be inventorying most of the field season.

Unsupervised Practice and Supervised Review

The practice and review session requires about 3 days in the field and includes the following:

1. Divide participants into typical-size crews (two or three people) and inventory a common stream segment. This practice allows crews to answer their own questions using their past education, what they have learned in training, and the written procedures. If questions remain, the crews should flag the place where a particular question arose and write it down either on the flag or in a notebook.
2. Revisit the stream segments where questions remain with everyone in attendance. Discuss the questions and other relevant topics that arose during the unsupervised practice. Review completed inventory forms and compare calls and measurements between crews. Allow adequate time for finding answers or clarifications.

Snorkel Training

Snorkel training should be limited to five or fewer participants and requires 1 day of training. This training includes:

1. Demonstrate proper and safe direct enumeration snorkeling techniques.
2. Describe morphological characteristics that distinguish fish species residing within your inventory basin. Choose a training stream that has a variety of species so that participants can see all species and their distinguishing characteristics. See "Underwater Methods for Study of Salmonids in the Intermountain West" (Thurow 1994) for color plates of various species and distinguishing characteristics.
3. Point out the difference in magnification of objects in air versus water. To demonstrate the difference, place your mask at the water level (half above and half below), hold two identical length objects above and below the water surface, and notice the difference. We also suggest that all participants estimate the lengths of underwater objects (such as wood dowels attached to a weight) of known size and compare their estimates to the known lengths. Crews should run through this same exercise periodically throughout the field season to keep their eyes calibrated. Crews should make estimates of various fish and compare their estimates.
4. For those species where individuals are placed into age classes rather than size classes, it takes repeated observations of a given species to feel comfortable breaking age classes. Therefore, it is helpful if fish from various age classes are pointed out to beginning snorkelers by someone who is experienced. Snorkel crews should be given adequate time to practice classifying fish and estimating size/age classes.

IV. Inventory Quality Control

The best data quality usually results from individuals who have had experience with these methodologies and who have worked somewhat with the data by proofing, entering data, producing reports, and so forth. Periodic inspections of data and collection techniques can also improve the quality, although the effect is more short term. Several methods can be used to improve the quality of inventory data, including:

1. Develop ownership between crews and the data they collect by showing them how summarized data assists in making wise resource management decisions.
2. Rotate field crew members through the office to enter data for a week or two. Crew members will soon get a better understanding of all facets of the inventory process, and this often results in improved data collection while in the field.

3. Periodically check completed inventory forms after they have been photocopied and filed and give feedback to the crews. Mistakes that plague data sets are often noticed by looking at the raw inventory forms.

4. Participate directly with the crews in the field, either by helping with data collection or by walking the stream and comparing the data on the forms to what is observed. Supervisors should then spend some time discussing differences and providing feedback.

V. Inventory Sampling Schemes

Data Collection Levels

We suggest three data collection levels to assist the biologist in designing a sampling scheme to meet Forest inventory objectives, available dollars, and time. The three levels (Level I, II, and III) vary in the number of habitat variables sampled at each habitat unit (table 8). Level I has the fewest variables per habitat unit and is the least effort to complete. Level II has habitat variables that coincide with PACFISH (USDA and USDI 1995) and FEMAT (USDA Forest Service 1993) habitat parameters for Riparian Management Objectives. Level III lists all habitat variables that are known to respond to direct (mechanical bank damage) and indirect (upstream cumulative disturbances) land uses and that are ecologically significant to aquatic life. Detailed summary discussions on habitat variables and their relation to land and fish use can be found in Chapman (1988), Everest and others (1987), MacDonald and others (1991), Meehan (1991), Overton and others (1995), Reid (1993), and Rhodes and others (1994).

Different combinations of variables can be selected to meet inventory objectives, funding, and time. At a minimum, however, the core set of variables in Level I must be collected to ensure linkage to existing broadscale coverages, assessments, and decision support tools. When deciding what variables to collect, also consider what the variables will provide in terms of summary outputs. For instance, if length, width, and average depth are collected, the summary outputs not only include means for these variables but also areas and volumes. Appendix F lists the variables and their summary outputs for the different levels using FBASE 3.0.

Table 8—Comparison between the variables collected at inventory Levels I, II, and III.

Level I	Level II	Level III
Header form variables	Header form variables	Header form variables
Habitat type[a]	Habitat type	Habitat type
Length	Length	Length
Average width	Average width	Average width
Average depth	Average depth	Average depth
Maximum depth	Pocket pools #,	Pocket pools #,
Crest depth	Average maximum depth[b]	Average maximum depth[b]
Bank length, stability[b]	Maximum depth	Maximum depth
Water temperature[c]	Crest depth	Crest depth
Comments	Step pools #, # >1 m,	Step pools #, # >1 m,
	Average maximum depth[b]	Average maximum depth[b]
	Surface fines[b]	Surface fines[b]
	Substrate comp.[c]	Substrate comp.[c]
	Bank length, stability[b]	Bank length, stability[b]
	Water temperature[c]	Bank undercut[b]
	Air temperature[c]	Channel shape[b]
	LWD counts	Water temperature[c]
	Riparian[b]	Air temperature[c]
	Comments	LWD counts
	Side channels	LWD dimensions, % submerged[b]
	Fish sampling[c]	Riparian[b]
		Comments
		Side channels
		Fish sampling[c]

[a]Habitat class or group can be substituted for habitat type (see table 5).

[b]These variables may also be subsampled (see table 9).

[c]Water and air temperature, substrate composition, and fish sampling are systematically subsampled as part of the standard procedures; therefore, no additional subsampling is recommended.

Resource Objectives and Data Summaries

The three data collection levels will address the following potential resource objectives:

1. Characterizes and quantifies the structure and pattern of fish habitat within the sampled area. For example, the percent composition by length, area, or volume of slow and fast water habitat types.
2. Provides data for determining habitat condition in relation to its potential for channel geometry measurements (Levels I through III) or all prescribed PACFISH habitat variables (Levels II and III). For example, the collected variables can be contrasted against similar reference habitat variables to judge current habitat condition.
3. Supplies data for developing future monitoring or subsampling strategies to assess and track habitat conditions through time. These levels of inventory allow for calculations of habitat descriptive statistics (mean, mode, variance) for channel geometry (Levels I through III) and PACFISH (Levels II and III) variables that can be used for designing a monitoring strategy. See Parkinson and others (1988) for a discussion on the use of power analysis to determine sample size.
4. Provides data that can be stratified by reach and channel type and watersheds with similar geoclimatic settings. These data can be extrapolated to unsampled areas.
5. Fish sampling (Levels II and III) provides general fish habitat relationship information, as well as fish composition and distribution for the inventoried reaches.

Subsampling Frequency

Different sampling frequencies (20 to 100 percent) can be applied to Levels II and III, which will alter data accuracy and inventory effort. Inventory objectives need to be well thought out to ensure that the selected sampling scheme meets resource data requirements and accuracy. We suggest that a statistician be consulted when matching inventory objectives with a sampling scheme. The variables that may be subsampled are supplied in table 8, and the different sampling frequencies and required effort are listed in table 9.

Data must be collected at enough habitat units to assure a large enough sample size for statistical analysis. At a minimum, 30 slow water and 30 fast water habitat units must be measured for the sample mean to approximate the true mean (Overton and others 1993). When a survey reach is delineated, an estimate should be made of how many habitat units are in each survey reach. If a survey reach has less than 60 habitat units, all data must be collected at all habitat units. If the survey reach has more than 60 habitat units, some variables may be subsampled, depending on the data collection level chosen. To calculate the subsampling percentage to meet the minimum sample size, follow this example:

1. Estimate the number of habitat units within your survey reach. Base your estimates on the complexity and size of the stream. For example, smaller headwater streams with numerous pool-forming obstructions (such as large woody debris and boulders) tend to have more habitat units per distance than larger streams in which the obstructions have been washed out by high flows. Your estimates should err on the low side. For this example, let's use n = 250 habitat units.
2. Estimate the number of fast water and slow water habitat types based on an estimated pool/riffle frequency ratio. For this example, let's use 1:1.5 pool/riffle frequency ratio or 100 slow water habitat types and 150 fast water habitat types.
3. Calculate your subsampling percentage by dividing your minimum sample size (n = 30) by the estimated number of slow water habitat types (or fast water habitat types, whichever is less). For this example, 30 divided by 100 equals 30 percent.
4. Round your calculated subsampling frequency up to the next higher established subsampling frequency (table 9) to assure that n = 30 is achieved. For this example, 30 percent would be rounded to 33 percent. In other words, data for subsampled variables is collected every third habitat unit.

Table 9—Established subsampling frequencies and number of required sampled habitat units to achieve the percent sampling frequency.

Sampling frequency percentage	Habitat unit measurement ratio
20	1 out of 5
25	1 out of 4
33	1 out of 3
50	1 out of 2
100	All

Conclusions

The R1/R4 Fish and Fish Habitat Inventory Procedures Handbook is the product of 5 years of development and evaluation. The handbook's primary function is to provide standard procedures for collecting fish and fish habitat data that will be comparable across multiple scales and can be linked to other resource databases (such as riparian and upland characterizations). The habitat variables represent channel features that have responded to watershed processes influenced by natural or human related disturbances within the drainage area. This stream

channel characterization provides the user with a look at current conditions or natural conditions to assist in determining habitat suitability in association with management actions at the scales of interest. These habitat variables and measurement procedures can be used to monitor changes through time for a selected assessment area.

Like most field data collection methodologies, conscientious and well-trained field technicians and biologists are the key to collecting quality data. The standard procedures must be followed to ensure the compatibility of data across scales.

The user may wish to refer to case studies that have used these habitat variables and procedures to analyze the effects of forest activities (Overton and others 1993) and grazing (Overton and others 1994), for the establishment of natural or reference conditions (Overton and others 1995), in the Upper Columbia River Basin aquatic science report (Lee and others, in press), and for spatially linking inventory data to GIS (Radko 1997). Examples on using these data for graphical and GIS spatial displays, information for fish habitat relationships, and monitoring design are forthcoming.

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R1/R4 Fish Habitat Inventory
FORM 1 - Header Data

Stream: ____________________ Stream ID: ____________________

Trib of: ____________________ Study/Year: ____________________

Survey Reach #: ____________________ Reach Type: ____________________

Survey Reach Lower Boundary: ____________________

Survey Reach Upper Boundary: ____________________

Forest: ____________________ Code: __________

District: ____________________ Code: __________

Admin. Forest: ____________________ Code: __________

Admin. District: ____________________ Code: __________

Non-USFS Inclusions(Y/N): __________ If Y, Owner: ____________________

Ecoregion: Bailey: __________ Gross Geology: ____________________

Omernik: __________ Sub-geology: ____________________

EPA Reach Number: ____________________

EPA Reach Lower Boundary: ____________________

EPA Reach Upper Boundary: ____________________

Location: T_____R_____S___;___1/16___1/4 Base Quad: ____________________

Survey Lat: ____________________ **Survey Long:** ____________________

Survey Date: ____________________ **Chan. Type:** ____________________

Observer: ____________________ **Cover Group:** ____________________

Recorder: ____________________ **Discharge:** ____________________

Elevation: ____________________ **Confinement:** ____________________

Map Grad.: ____________________ **Weather:** ____________________

Obs. Grad.: ____________________ Wilderness: ____________________

Comments: (Back side of form)

Note: Complete bolded variables in the field; complete all others prior to field work.

$$\text{Discharge (Q)} = \frac{W \times D \times k \times L}{T}$$

T = _____s k = _____
W = _____m L = _____m
D = _____m

	T	W	D
1	_____s	_____m	_____m
2	_____s	_____m	_____m
3	_____s	_____m	_____m
Avg.	_____s	_____m	_____m

(Time, width, and depth measurements for discharge calculation)

FORM 1 - Header Data (01/17/96)

R1/R4 Fish Habitat Inventory
FORM 2 - Habitat Inventory Form

Stream: ____________ Reach #: ____________ Page: ____________
Forest: ____________ Observer: ____________ Date: ____________
District: ____________ Recorder: ____________ Weather: ____________

HABITAT UNIT #										
CHANNEL CODE										
SIDE UNIT #										
HABITAT TYPE										
LENGTH										
WIDTH										
AVG. DEPTH										
FAST TYPE										
# POCKET POOLS										
AVG. MAX DEPTH										
SLOW TYPE										
MAX DEPTH										
CREST DEPTH										
STP STEP POOL #										
STP # POOLS >1m										
STP AVG. MAX DP										
SURFACE FINES %										
Substrate Comp.										
Bank Length (L)										
Bank Length (R)										
Length/Percent										
Stable (L)										
Undercut (L)										
Stable (R)										
Undercut (R)										
Chan Shape (L)										
Chan Shape (R)										
Water Temp										
Air Temp										
Temp Time										
LWD SINGLES										
LWD AGGREGATES										
LWD ROOT WADS										
Riparian										
RCT1 (L)										
RCT2 (L)										
RCT1 (R)										
RCT2 (R)										
COMMENTS (X)										
Snorkel Tally										

NOTE: Capitalized variables (except RCT1 and RCT2) are collected in all reach types and side channels

FORM 2 - Habitat Inventory Form (01/17/96)

R1/R4 Fish Habitat Inventory
FORM 3 - Substrate Composition

Stream:______________________________ Reach #:_________ Date:_____________ Page:_________

Hab Unit #	Method*	Fines <2mm	Small Gravel 2-8mm	Gravel 8-64mm	Small Cobble 64-128mm	Cobble 128-256mm	Small Boulder 256-512mm	Boulder >512mm	Bedrock

*WPC = Wolman pebble count (Measured)
*EST = Ocular (Estimated)

R1/R4 Fish Habitat Inventory
FORM 4 - Large Woody Debris

Stream:________________________ Reach #:________ Date:___________ Page:________

Single Pieces			Single Pieces			Aggregates		Aggregates	
Hab Unit #	Ln X Dia	% Submg.	Hab Unit #	Ln X Dia	% Submg.	Hab Unit #	# Pcs.	Hab Unit #	# Pcs.

FORM 4 - Large Woody Debris (01/17/96)

R1/R4 Fish Habitat Inventory

FORM 5 - Comments

Stream:______________________________ Reach #:_________ Date:_____________ Page:_________

Hab. #	Comments: Habitat/Fish (Circle One)

PHOTOGRAPHS

Hab.#	R#	EX#	Description	Hab.#	R#	EX#	Description

FORM 5 - Comments (01/17/96)

R1/R4 Fish Habitat Inventory
FORM 6 - Fish Data

Stream:______________________________ Reach #:_________ Date:_____________ Page:_________
Diver1 (D1):___________________________ Diver2 (D2):____________________________

Habitat Unit #										
Habitat Type										
Habitat Length										
Dist. Betw. Units										
Dive Date										
Dive Water Temp										
Dive Air Temp										
Dive Time										
DIVE LENGTH										
DIVE AVG. WIDTH										
DIVE AVG. DEPTH										
Dive Max Depth										
% Undercut Bank										
% Overhead Cover										
% Submerged Cover										
% Large Substrate										

COUNTS	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
CHIN 0 (50-80)																				
CHIN 1 (> 100)																				
Adult Chinook																				
ST1 (70-130)																				
ST2 (130-200)																				
ST3 (200-250)																				
RB > 250																				
RD < 100																				
RD 100-200																				
RD > 200																				
CT < 100																				
CT 100-200																				
CT 200-300																				
CT > 300																				
BT < 100																				
BT 100-200																				
BT 200-300																				
BT 300-400																				
BT 400-500																				
BT > 500																				
BK < 100																				
BK 100-200																				
BK 200-300																				
BK > 300																				
BN < 100																				
BN 100-200																				
BN 200-300																				
BN 300-400																				
BN > 400																				
YOY <70 (+ = Yes)																				
No Fish (X = Yes)																				
Comments (X)																				

CHIN = Chinook, ST = Steelhead, RB = Rainbow, RD = Redband, CT = Cutthroat,
BT = Bull Trout, BK = Brook Trout, BN = Brown Trout, YOY = Young-of-the-Year
NOTE: Capitalized variables are required fields

FORM 6 - Fish Data (01/17/96)

R1/R4 Fish Habitat Inventory
FORM 1 - Header Data

Stream: SKELETON CR Stream ID: ID8561

Trib of: BOISE R, S FK Study/Year: I95

Survey Reach #: 2 Reach Type: B

Survey Reach Lower Boundary: LITTLE RATTLESNAKE CR

Survey Reach Upper Boundary: SKELETON CR, E FK

Forest: SAWTOOTH NF Code: F14

District: FAIRFIELD RD Code: D05

Admin. Forest: SAWTOOTH NF Code: F14

Admin. District: FAIRFIELD RD Code: D05

Any Non-USFS Inclusions(Y/N)? N If Y, Owner:

Ecoregion: Bailey: 342 Gross Geology: SEDIMENTARY

Omernik: 12 Sub Geology: COARSE

EPA Reach Number: 1705011307100.00

EPA Reach Lower Boundary: MOUTH

EPA Reach Upper Boundary: HEADWATERS

Location: T 3N R 12E S 1 ; NE 1/4; SW 1/4 Base Quad: NEWMAN PEAK

Survey Lat: 37'30" Survey Long: 115°

Survey Date: 7/16/95 - 7/25/95 Chan. Type:

Observer: S. WOLLRAB Cover Group: WOODED

Recorder: L. LEATHER Discharge: 0.42 m^3/s

Elevation: 1805 M Confinement: MODERATE

Map Grad.: 3.2 % Weather: PT CLOUDY

Obs. Grad.: 2.6% Wilderness: NO

Comments: (Back side of form)

Note: Complete bolded variables in the field; complete all others prior to field work.

Discharge (Q) = $\frac{W \times D \times k \times L}{T}$

T = 9.03 s k = 0.85
W = 3.73 m L = 10.0m
D = 0.12 m

	T	W	D
1	9.2 s	3.4 m	.13 m
2	8.5 s	4.2 m	.11 m
3	9.4 s	3.6 m	.12 m

(Time, width, and depth measurements for discharge calculation)

FORM 1 - Header Data (11/16/95)

R1/R4 Fish Habitat Inventory
FORM 2 - Habitat Inventory Form

Stream: SKELETON CR Reach #: 2 Page: 1
Forest: SAWTOOTH NF Observer: S. WOLLRAB Date: 7-20-95
District: FAIRFIELD RD Recorder: L. LEATHERBURY Weather: PT CLOUDY

HABITAT UNIT #	1	2	3	3	4	4	4	5	6	7
CHANNEL CODE	M	M	M	A	M	S	S	M	M	M
SIDE UNIT #	0	0	0	1	0	1	2	0	0	0
HABITAT TYPE	LGR	SPW	RUN	DBW	LGR	LGR	SMW	HGR	SPW	RUN
LENGTH	15.2	7.3	4.0	3.2	22.5	8.1	1.8	12.4	9.2	5.1
WIDTH	3.4	4.5	1.8	1.5	3.7	1.2	1.5	3.3	4.6	2.8
AVG. DEPTH	.10	.16	.14	.15	.09	.03	.10	.13	.17	.11
FAST TYPE										
POCKET POOLS #	0		0		1	2		3		0
AVG. MAX-DPTH	—		—		.18	.16		.17		—
SLOW TYPE										
MAX DEPTH		.32		.25			.21		.35	
CREST DEPTH		.09		.04			.06		.10	
STEP POOL #		—		—			—		—	
# POOLS > 1 M		—		—			—		—	
AVG. MAX DEPTH		—		—			—		—	
SURFACE FINES%	15	25	—	—	10	20	30		35	—
Substrate Comp	X									
Bank Length(L)	15.8	7.2	4.0		25			12.6	9.3	5.1
Bank Length(R)	14.9	7.3	4.0		21.5			11.5	9.4	4.9
Length/Percent										
Stable Left	90	100	15		85			90	100	100
Undercut Left	0	35	0		0			0	60	0
Stable Right	100	95	15		70			85	100	100
Undercut Right	0	60	0		0			0	40	0
Chan. Shape(L)	I	I	I		I			I	Z	R
Chan. Shape(R)	Z	Z	I		I			I	I	R
Temp H20	15°C									
Temp Air	36°C									
Temp Time	1000									
LWD SINGLES	2	0	2		3			0	1	0
LWD AGGREGATES	0	1	0		2			1	1	0
LWD ROOT WADS	0	0	0		0			0	1	0
Riparian										
RCT1 (L)	CC3	→	→		CC3			CC3	→	→
RCT2 (L)	SR4	→	→		SR4			SR4	→	→
RCT1 (R)	CC3	→	→		CC3			CC3	→	→
RCT2 (R)	SR4	→	→		SR4			SR4	→	→
COMMENTS (X)	X		X			X				X
Snorkel Tally	X	X	X	—	2	—	—	X	2	2

NOTE: Capitalized variables (except RCT1 and RCT2) are collected in all reach types and side channels

FORM 2 - Habitat Inventory Form (11/16/95)

R1/R4 Fish Habitat Inventory
FORM 3 - Substrate Composition

Stream: Skeleton Cr Reach #: 2 Date: 7-20-95

Hab Unit #	Method*	Fines <2mm	Small Gravel 2-8mm	Gravel 8-64mm	Small Cobble 64-128mm	Cobble 128-256mm	Small Boulder 256-512mm	Boulder >512mm	Bedrock
1	WPC	10	4	21	36	20	9	10	0

*WPC = Wolman pebble count (Measured)
*EST = Ocular (Estimated)

R1/R4 Fish Habitat Inventory
FORM 4 - Large Woody Debris

Stream: SKELETON CR   Reach #: 2   Date: 7-20-95

Single Pieces			Single Pieces			Aggregates		Aggregates	
Hab Unit #	Ln X Dia	% Submg.	Hab Unit #	Ln X Dia	% Submg.	Hab Unit #	# Pcs.	Hab Unit #	# Pcs.
1	8 X .12	10	1	6.4 X .17	50	2	4	4	3
3	4 X .16	100	3	12 X .12	70	4	2	5	4
4	12 X .18	90	4	20 X .10	30	6	3		
4	9 X .12	50	6	4.5 X .12	40				

FORM 4 - Large Woody Debris (11/16/95)

R1/R4 Fish Habitat Inventory
FORM 5 - Comments

Stream: SKELETON CR Reach #: 2 Date: 7-20-95

Hab. #	Comments: Habitat Fish (Circle One)
1	START OF REACH - THERMOGRAPH DEPLOYED NEAR RB
3	MOTORCYCLE CROSSING CAUSING BANK EROSION; TRACKS IN CREEK
4	SIDE CHANNEL SEPARATED BY GRAVEL BAR - NO VEG.
7	TWO DEAD RBT ON RB, CAUSE UNKNOWN. (NO OBVIOUS SIGNS)

PHOTOGRAPHS

Hab.#	R#	EX#	Description	Hab.#	R#	EX#	Description
1	1	1	Start of reach - US				
1	1	2	RCT - RB				
1	1	3	RCT - LB				
7	1	4	2 Dead RBT - RB				

R1/R4 Fish Habitat Inventory
FORM 6 - Fish Data

Stream: SKELETON CR Reach #: 2 Date: 7-28-95
Diver1 (D1): S. WOLLRAB Diver2 (D2): N/A

Habitat Unit #	1	2	3	5						
Habitat Type	LGR	SPW	RUN	HGR						
Habitat Length	15.2	7.3	4.0	12.4						
Dist. Betw. Units	0	0	0	22.5						
Dive Date	7-28	→	→	→						
Dive Water Temp	14°C	14°C	14°C	14°C						
Dive Air Temp	42°C	42°C	42°C	42°C						
Dive Time	1020	1030	1040	1050						
DIVE LENGTH	15.0	7.6	4.7	12.9						
DIVE AVG. WIDTH	3.2	4.4	1.6	3.2						
DIVE AVG. DEPTH	.09	.17	.12	.13						
Dive Max Depth	—	.38	—	—						
% Undercut Bank	50	40	10	0						
% Overhead Cover	60	50	20	5						
% Submerged Cover	20	50	10	10						
% Large Substrate	10	20	20	20						

COUNTS	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2	D1	D2
CHIN 0 (50-80)																				
CHIN 1 (> 100)																				
Adult Chinook																				
ST1 (70-130)																				
ST2 (130-200)																				
ST3 (200-250)																				
RB > 250																				
RD < 100	6		1		4		3													
RD 100-200	1		3		1		2													
RD > 200							1													
CT < 100																				
CT 100-200																				
CT 200-300																				
CT > 300																				
BT < 100							1													
BT 100-200					1		1													
BT 200-300			1																	
BT 300-400																				
BT 400-500																				
BT > 500																				
BK < 100																				
BK 100-200																				
BK 200-300																				
BK > 300																				
BN < 100																				
BN 100-200																				
BN 200-300																				
BN 300-400																				
BN > 400																				
YOY <70 (+ = Yes)	+		+		+		+													
No Fish (X = Yes)																				
Comments (X)																				

CHIN = Chinook, ST = Steelhead, RB = Rainbow, RD = Redband, CT = Cutthroat, BT = Bull Trout, BK = Brook Trout, BN = Brown Trout, YOY = Young-of-the-Year
NOTE: Capitalized variables are required fields

FORM 6 - Fish Data (11/16/95)

Appendix C: Glossary of Fish Habitat Terms

Alluvium—All deposits resulting directly or indirectly from the sediment transport of streams, including the sediments laid down in riverbeds, floodplains, lakes, fans, and estuaries (in other words, river laid material in a stream valley). A more or less stratified deposit of gravel, sand, silt, clay, or other debris, moved by streams from higher to lower ground.

Anadromous—Moving from the sea to fresh water for reproduction.

Backwater—Pool formed by an eddy along a channel margin downstream from obstructions such as bars, rootwads, or boulders, or resulting from back-flooding upstream from an obstructional blockage. Also, a body of water, the stage of which is controlled by some feature of the channel downstream from the backwater, or in coves or covering low-lying areas and having access to the main body of water.

Bankfull stage—The stage at which water starts to flow over the floodplain; the elevation of the water surface at bankfull discharge.

Bankfull width—The width (surface) of the stream at bankfull stage.

Bole—The stem or trunk of the tree.

Cascade—Habitat type characterized by swift current, exposed rocks and boulders, high gradient, and considerable turbulence and surface agitation, and consisting of a stepped series of drops.

Channel—A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine the water.

Channel type/Stream type—A classification of stream channels based on entrenchment, gradient, width/depth ratio, sinuosity, and dominant channel material (Rosgen 1994).

Chute—A narrow, confined channel through which water flows rapidly; a rapid or quick descent in a stream, usually with bedrock substrate.

Class—A number of things grouped together because of certain likenesses or common traits.

- **Age class**—A group of individuals of a species that belong in the same age group (in other words, were hatched in the same year). Individual fish will exhibit a total length that falls within lower and upper bounds. For example, age II steelhead trout range in length from 130 to 200 mm.
- **Size class**—A group of individuals of a species having the same length within specified lower and upper bounds. For example, cutthroat trout from 100 to 200 mm.

Collected variable—A quantity measured or estimated to a predetermined level of precision (such as, max depth, average width, percent surface fines, observed gradient, length undercut bank, and so forth).

Colluvium—A general term for loose deposits of soil and rock moved by gravity (such as, talus, landslides).

Complex—A group of interconnected similar units (such as, step pool complex, side channel complex, beaver dam complex).

Contour lines—Lines on a topographic map that connect points of equal elevation.

Cover—Suspended material covering the land or water; measured as a percentage of the surface area when looking from above.

- **Fish**—Anything that provides protection from predators or improves adverse conditions of streamflow or seasonal changes in metabolic costs. This may be overhead cover or submerged cover and it may be used for escape, feeding, hiding, or resting.
- **Overhead**—White water, surface turbulence, bank vegetation, tree branches, floating logs, or other debris that are touching or are within 0.3 m of the water surface.
- **Submerged**—Large woody debris, other organic debris, ledges, or aquatic vegetation which are below the water surface.

Crest—Break or transition in stream channel slope between habitat units.

- **Head**—Break in stream channel slope located at the head of a pool.
- **Tail**—Break in stream channel slope located at the tail of a pool.

Density—Number of organisms or items per unit area or volume.

Depth—The vertical distance from the water surface to the streambed.

Diameter—The length of a straight line through the center of an object; thickness.

Discharge—The volume of water flowing in a given stream at a given place and within a given period, usually expressed as feet^3/second (cfs) or meter^3/second (cms).

Diversion—A temporary removal of surface flow from the channel; distributary.

Ecoregion—Regions exhibiting common land-surface form, climate, vegetation, soils, and fauna.

Ecosystem management—Conservation and use of natural resources that serves to maintain biological diversity, long-term site productivity, and sustainability of resource production and use (Marcot and others 1994).

Exclosure—An area from which livestock or other animals are excluded.

Falls—A free fall or steep descent of water.

Fish habitat—The aquatic environment and the immediately surrounding terrestrial environment that, combined, afford the necessary biological and physical

support systems required by fish species during various life history stages.

Floodplain—Level lowland adjacent to the bankfull channel onto which the stream spreads at flood stage.

Flow—The movement of a stream of water from place to place; the volume of water passing a given point per unit of time; discharge. Measured in cubic feet per second (cfs) or cubic meters per second (cms).

Bankfull—The discharge corresponding to the stage at which the floodplain of a particular stream reach begins to be flooded. The point at which overbank flow begins.

Base level—Portion of stream discharge derived from such natural storage sources as ground water, large lakes, and swamps situated outside the area of net rainfall that creates local surface runoff; the sustained discharge that does not result from direct runoff or from stream regulation, water diversion, or other human activities.

Fluvial—Pertaining to streams or rivers, or produced by stream action. Also used to describe fish that migrate between main rivers and tributaries.

Forb—Any broad-leaved herbaceous plant other than those in the Gramineae (Poceae), Cyperaceae, and Juncaceae families (Society for Range Management 1989).

Glide—A fast water habitat type that has low to moderate velocities, no surface agitation, no defined thalweg, and a U-shaped, smooth, wide bottom.

Gradient—The general slope, or rate of change, in vertical elevation per unit of horizontal distance of the water surface of a flowing stream.

Grass—An annual or perennial herb, generally with round hollow erect stems and swollen nodes; leaves are alternate and two-ranked; flowers are in spikelets each subtended by two bracts (Green 1991).

Habitat type (aquatic)—Aquatic unit defined by its structure, function, and formative features.

Habitat unit—An individual unit of one aquatic habitat type. This individual unit can be found in main channels or side channels, or attached to a main or side channel unit (adjacent).

Intermittent stream—A stream in contact with the ground water table that flows only certain times of the year, such as, when the ground water table is high or when it receives water from springs or from some surface source such as melting snow in mountainous areas. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available streamflow.

Inventory—An account or catalog of aquatic variables that describes both the quality and quantity of fish habitat.

Island—Areas of land between the streambanks that are surrounded on all sides by a portion of the stream's water.

Gravel bar—An island with little or no established vegetation or streambanks; also called channel or mid-bars.

Vegetated—An island with established vegetation and streambanks.

Large woody debris—Large pieces of relatively stable woody material located within the bankfull channel and appearing to influence bankfull flows. These are categorized as singles, aggregates, or rootwads.

Single—A single piece that has a length equal to or greater than 3 m or two-thirds of the wetted stream width and 0.1 m (10 cm) in diameter one-third of the way from the base.

Aggregate—Two or more clumped pieces, each of which qualifies as a single piece.

Rootwad—Rootmass or boles attached to a log less than 3 m in length.

Landslide—Any sudden movement of earth or rocks or both down a steep slope.

Main channel—The principal, largest, or dominating stream or channel of any given area or drainage system.

Meander—A winding section of stream with many bends that is at least 1.5 times longer, following the channel, than its straight-line distance. A single meander generally comprises two complete opposing bends, starting from the relatively straight section of the channel just before the first bend to the relatively straight section just after the second bend.

Parr—Young salmonid, in the stage between alevin and smolt, that has developed distinctive dark "parr marks" on its sides and is actively feeding in fresh water.

Perennial stream—A stream that flows continuously throughout the year; permanent.

Point bar—Sediments deposited at the convex (inside) bank of a stream bend or meander.

Pool—A portion of the stream with reduced current velocity, often with water deeper than the surrounding areas.

Damned—Pool formed by downstream damming action. Dam pools can be located in main channel (or side channel) or backwaters.

Scour—Pool formed by scour action when flowing water impinges against and is diverted by a streambank or channel obstruction (rootwad, woody debris, boulder, bedrock, and so forth). Scour pools may be lateral scour, mid-scour, plunge, or underscour pools.

Lateral scour—A pool formed by the scouring action of the flow as it is directed laterally or obliquely to one side of the stream by a partial channel obstruction, such as a gravel bar or wing deflector, or by a shift in channel direction.

Mid-channel scour—A pool formed by the scouring action of the flow as it is directed toward the

middle of the channel by a partial channel obstruction.

Plunge—A pool formed by scouring action from vertically falling water.

Underscour—A pool formed by scouring under an obstruction, such as a log. Sometimes called an upsurge pool.

Pocket—Small bed depressions, often less than 30 percent of wetted width, formed around channel obstructions (boulders, logs, irregular bank, jutting peninsulas, and so forth) within fast water habitat types.

Profile—A depiction of certain characteristics, usually depth, bed configuration, substrate, and velocity, of a longitudinal or transverse section of a stream.

Protocol—The formal arrangement of procedural steps.

Range—A row or line of Townships used in the Public Land System lying between two successive meridian lines 6 miles apart.

Reach type—Gross level channel type adapted from Rosgen (1985); "A" reach type = map gradient greater than 4 percent; "B" reach type = map gradient between 1.5 and 4 percent; "C" reach type = map gradient less than 1.5 percent.

Redd—Nest made in gravel, consisting of a depression hydraulically dug by a fish for egg deposition (and then filled) and associated gravel mounds.

Response reach—A reach that is low-gradient and transport-limited, and in which significant morphologic adjustment occurs in response to increased sediment supply (Montgomery and Buffington 1993).

Riffle—Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

Riparian area—The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Riparian community type—A repeating, classified, defined, and recognizable assemblage of riparian plant species (USDA Forest Service 1992).

Riparian influence zone—All areas where vegetation is influenced by high water tables through much of the growing season, as well as all upland areas within 30 m of the stream channel (Green 1991).

Riparian vegetation—Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

Run—A habitat type that is deep and fast with a defined thalweg and little surface agitation.

Scour—The localized removal of material from the streambed by flowing water.

Scour mark—High water mark on the streambank left by peak flows, often characterized by darkening of the rocks by lichens and mosses.

Section—One square mile (640 acres) into which the land is divided using the Public Land System; one-36th of a Township.

Sedge—A grasslike, fibrous-rooted herb with a triangular to round stem, and leaves that are mostly three-ranked and with closed sheaths; flowers are in spikes or spikelets, axillary to single bracts (Green 1991).

Sediment—Fragmental material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural processes.

Shrub—A plant that has persistent, woody stems and a relatively low growth habit, and that generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature (generally less than 5 m or 16 feet) and nonarborescent form (Society for Range Management 1989).

Sinuosity—The ratio of channel length between two points to the straight-line distance between the same points. Channels with sinuosities greater than or equal to 1.5 are termed meandering, while those close to 1.0 are straight.

Side channel—A lateral channel with an axis of flow roughly parallel to the mainstem and which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel.

Source reach—Reach that is a transport-limited, sediment storage site subject to intermittent debris flow scour (Montgomery and Buffington 1993).

Stable bank—A streambank that shows no evidence of breakdown, slumping, tension cracking or fracturing, or vertical erosion (Bauer and Burton 1993).

Stream—A natural water course containing flowing water, at least part of the year, supporting a community of plants and animals within the stream channel and the riparian vegetation zone.

Streambank—The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom.

Streambed—The substrate plane, bounded by the streambanks, over which the water column moves. Also called stream bottom.

Substrate—The mineral or organic material that forms the bed of the stream.

Fines—Substrate less than 2 mm.

Small gravel—Substrate between 2 and 8 mm.

Gravel—Substrate between 8 and 64 mm.

Small cobble—Substrate between 64 and 128 mm.
Cobble—Substrate between 128 and 256 mm.
Small boulder—Substrate between 256 and 572 mm.
Boulder—Substrate greater than 572 mm.
Bedrock—Solid rock making up the streambed.

Surface fines—That portion of streambed surface consisting of sand/silt (less than 6 mm).

Survey reach—A stream segment of uniform reach type between named (or large unnamed) perennial streams.

Tail—A transition between habitat types, it is the downstream section of a pool, usually shallow and with velocity increasing with shallowing; tailout.

Thalweg—The line followed by the majority of the streamflow. The line connecting the lowest or deepest points along a streambed.

Township—A division of land surface that is, with certain exceptions, 6 miles on its south and east and west boundaries, which follow meridians, and so slightly less than 6 miles on the north. It contains 36 sections.

Topographic map—A map graphically depicting the configuration of the landscape, including relief (elevational differences), the position of its streams, lakes, road, hot springs, cities, and so forth. For example, a 7.5 minute topographic map is a scale of 1:24,000, or 1 inch = 2,000 ft, or 1 cm = 240 m.

Transect—A line perpendicular to the flow of water, from one bank to the other, across which measurements are taken.

Transport reach—Reach that is morphologically resilient, high-gradient, and supply-limited, and that rapidly conveys increased sediment inputs (Montgomery and Buffington 1993).

Tributary—A stream feeding, joining, or flowing into a lake or larger stream.

Turbulence—The motion of water where local velocities fluctuate and the direction of flow changes abruptly and frequently at any particular location, resulting in disruption of laminar flow. It causes surface disturbance and uneven surface level, and often masks subsurface areas because air bubbles are suspended in the water.

Undercut bank—A bank that has had its base cut away at least 5 cm by the water or has been artificially made and overhangs directly above the water surface.

Unstable bank—A streambank that shows evidence of breakdown, slumping, tension cracking or fracturing, or vertical erosion (Bauer and Burton 1993).

Valley confinement—The ratio of valley width to bankfull channel width (in other words, valley width divided by bankfull channel width).

Velocity correction coefficient—An empirical coefficient used to compute stream roughness for determining water velocity in stream discharge calculations.

Watershed—Total land area draining to any point in a stream, as measured on a map, aerial photo, or other horizontal plane. Also called catchment area, drainage area, and drainage basin.

Watershed analysis—An assessment of the condition of a watershed.

Water table—Irregular surface of contact between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

Wetted width—The width of the water surface measured at right angles to the direction of flow.

Whitewater—Occurs where flows are sufficiently fast and turbulent to entrain air bubbles in the water.

Young-of-year (YOY)—A juvenile fish less than 1 year old.

Appendix D: Equipment

Inventory Equipment:

- R1/R4 Fish and Fish Habitat Inventory Procedures Handbook
- Inventory forms (on weatherproof paper) or data logger (optional)
- Clip board
- Pencils
- Hand-held thermometer or continuous recording thermograph
- Hand level
- Rubber sponge ball
- Survey reach maps
- Completed Header forms (Form 1)
- Work vest or day pack
- Two-way radio
- Flagging (two to three rolls)
- Permanent ink pens (two or three)
- Waterproof footwear - neoprene or flyweight waders and felt sole boots; or hipboots with cleated slippers
- Weather resistant 35 mm camera with date back and zoom lens/dual lenses
- Slide film - 24 or 36 exposure Ektachrome for quick developing
- 30 or 50 m drag chain or tape measure
- 2 m stadia rod marked off in 10 cm increments
- 15 cm ruler marked off in 1 mm increments
- Polarized glasses
- Two or three inexpensive solar-powered calculators
- Surface fines grid (optional)
- Compass
- Access maps

Camping Equipment (if needed):

- Tent
- Backpack
- Cooking and eating utensils
- Sleeping bag and pad
- Water filter and bottles
- Backpack stove, fuel bottle, and fuel
- Camp trowel
- First aid kit
- Food and water

Snorkeling Equipment:

- ¼ inch neoprene wet suit with farmer John style bottoms and step-in style tops
- ¼ inch neoprene hood and neoprene river socks without hard soles
- Neoprene gloves with re-enforced finger tips (shoe goo or tool dip-it with sprinkles of sand)
- Felt soled wading boots
- Colored snorkel - not clear (with at least one purge valve, but with as few joints as possible)
- Mask with single piece lenses (prescription lenses can be ordered)
- Swimmers ear medication
- Aquaseal (small tube)
- Anti-fog for masks
- Day pack or breathable duffle bag/pack
- Underwater writing slate (polyvinyl chloride cuff) with attached pencils
- 2 m stadia rod marked off in 10 cm increments
- 50 m tape measure
- Fish forms (Form 8) on weather-proof paper
- Clip board
- Thermometer
- 35 mm camera (optional)
- Pencils with extra lead and erasers

Slide Organization Equipment:

- Three-ring binder
- Divider page with tabs
- 8.5 inch by 11 inch polyethylene (not polyvinyl chloride) slide protection pages
- Fine point pen
- Comment form (Form 6) with the comments that are to be transferred to the slides
- Developed slides

Appendix E: Riparian Community Types, an Example (Green 1991)

Plant Communities

1a. Tree canopy is more than 10 percent:

2a. Dominant tree species are grand fir, western redcedar, or Pacific yew

3a. Shrub canopy cover is more than 10 percent

4a. Site is well drained with species similar to upland plant communities: mountain maple, oceanspray, blue huckleberry, snowberry, hawthorn, thimbleberry, syringa, serviceberry, clintonia, ginger, goldthread. **CM1**

4b. Site is very moist, species indicate environment wet throughout the growing season: cascara, alder, willow, red osier dogwood, stream boykinia, arrowleaf groundsel, ladyfern. **CM2**

3b. Shrub canopy cover is less than 10 percent.

5a. Site is well drained with forb species similar to upland plant communities: clintonia, ginger, goldthread, beargrass. **CM3**

5b. Site is very moist, species indicate environment wet throughout the growing season: stream boykinia, Carolina bugbane, arrowleaf groundsel, or ladyfern. **CM4**

2b. Dominant tree species are subalpine fir, lodgepole pine, Engelmann spruce, or whitebark pine.

6a. Shrub canopy cover is more than 10 percent

7a. Site is well drained with species similar to upland plant communities: blue huckleberry, twinflower, grouse whortleberry, menziesia, or beargrass. **CC1**

7b. Site is very moist, species indicate environment is wet throughout the growing season: alder, willow, laborador tea, licoriceroot, arrowleaf groundsel, or Carolina bugbane. Menziesia, grouse whortleberry, dwarf huckleberry and beargrass are confined to better drained hummocks. **CC2**

6b. Shrub canopy cover is less than 10 percent.

8a. Site is well drained with forb species similar to upland plant communities: beargrass, elk sedge, arnica, rattlesnake plantain. **CC3**

8b. Site is very moist, herbaceous species indicate environment is wet throughout growing season: sedges, wet site grasses, marsh marigold, Carolina bugbane, arrowleaf groundsel, twisted stalk, licoriceroot. Dry site forbs are confined to hummocks. **CCR**

2c. Dominant species are Douglas-fir or ponderosa pine. Dry sites with no potential to support grand fir, cedar, or subalpine fir.

9a. Shrub canopy cover is 10 percent or more. **CD1**

9b. Shrub canopy cover is less than 10 percent. **CD3**

2d. Dominant species are broadleaf deciduous trees more than 20 feet tall at maturity: white or red alder, paper or water birch, black cottonwood, or aspen.

10a. Shrub canopy cover is 10 percent or more. **BB2**

10b. Shrub canopy cover is less than 10 percent. **BB4**

1b. Tree canopy cover is less than 10 percent.

11a. Shrub canopy cover is 10 percent or more

12a. Site is very moist, shrub and herbaceous species indicate environment is wet throughout the growing season: willow, alder, cascara, red osier dogwood.

13a. Herbaceous layer is wet site grasses and sedges. **SR2**

13b. Herbaceous layer includes wet site forbs as well as grasses and sedges. **SR4**

12b. Site is well drained, shrub and herbaceous species indicate environment is not wet throughout the growing season: mountain maple, hawthorn, serviceberry, snowberry, ninebark, oceanspray, or spirea. **SD1**

11b. Shrub canopy cover is less than 10 percent.

13a. Herbaceous (grass and forb) cover is more than 10 percent.

14a. Site is wet, dominated by sedges. **GR2**

14b. Site is very moist to wet, dominated by grasses or forbs or both, usually too wet to be heavily grazed except for short periods. **GR4**

14c. Site is moist, dominated by grasses and forbs that indicate grazing disturbance, with dandelion, yarrow, clover or other weedy species. **GRD**

14d. Site is well drained and herbaceous species indicate environment is dry for extended periods in the growing season:

15a. Grass dominated **GD1**

15b. Forb, or forb and grass dominated **HD1**

13b. Less than 10 percent plant cover **XX1**

Nez Perce Riparian Community Type Codes

CM1	Upland grand fir/cedar community with midshrub/forb understory
CM2	Riparian grand fir/cedar community with wetland shrub/forb understory
CM3	Upland grand fir/cedar community with upland forb understory
CM4	Riparian grand fir/cedar community with wetland forb understory
CC1	Upland subalpine fir/lodgepole community with upland midshrub/forb understory
CC2	Riparian subalpine fir/lodgepole community with wetland midshrub/forb understory
CC3	Upland subalpine fir/lodgepole community with upland forb understory
CCR	Riparian subalpine fir/lodgepole community with riparian/wetland forb or graminoid understory
CD1	Douglas-fir/ponderosa pine with midshrub/forb understory
CD3	Douglas-fir/ponderosa pine with forb/graminoid understory
BB2	Broadleaf deciduous with shrub/forb understory
BB4	Broadleaf deciduous with forb understory
SR2	Riparian willow/alder (and so forth) with wet site grasses and sedges
SR4	Riparian willow/alder (and so forth) with wet site forbs/grasses/sedges
SD1	Upland shrub species
GR2	Grass and forb cover dominated by riparian sedges
GR4	Riparian grasses/forbs
GRD	Riparian grasses/forbs with grazing indicators
GD1	Upland grass dominated
HD1	Upland forb/grass dominated
XX1	Plant cover less than 10 percent (unvegetated)

Appendix F: Summary Variable Outputs for Sampling Levels I Through III Using FBASE 3.0

Level	Variable	Summary output
I-III	Header form variables	No summary outputs
I-III	Habitat type, group, or class	Number of units within type, group, or class
I-III	Habitat length	Total habitat length Mean habitat length Percent habitat length
I-III	Average width	Mean width Total habitat area (length, width)[a] Mean habitat area (length, width)[a] Percent habitat area (length, width)[a]
I-III	Average depth	Mean average depth Width/depth ratio (width, avg. depth)[a] Total habitat volume (length, width, avg. depth)[a] Mean habitat volume (length, width, avg. depth)[a] Percent habitat volume (length, width, avg. depth)[a]
II, III	Pocket pools (count, average maximum depth)	Total number of pocket pools Mean number of pocket pools Number of pocket pools per 100 m Mean depth of pocket pools
I-III	Maximum depth	Mean maximum depth
I-III	Crest depth	Mean crest depth Mean residual maximum depth (max. depth, crest depth)[a] Total residual volume (max. depth, crest depth, length, width)[a] Mean residual volume (max. depth, crest depth, length, width)[a]
II, III	Step pool complexes	Total number of pools in step pool complexes Average maximum depth of step pool complexes
II, III	Percent surface fines	Mean percent surface fines
II, III	Substrate composition	Mean percent substrate coverage for each substrate class
I-III	Bank length	Total bank length for left and right banks
I-III	Percent or length bank stability	Percent stable bank for left and right banks, and mean (bank length)[a] Percent unstable bank for left and right banks, and mean (bank length)[a]
III	Percent or length undercut	Percent undercut bank for left and right banks, and mean (bank length)[a]
III	Channel shape	No summary outputs
I-III	Water temperature	No summary outputs
II, III	Air temperature	No summary outputs
II, III	Large woody debris counts	Total number of single pieces, aggregates, and rootwads Mean number of single pieces, aggregates, and rootwads Number of single pieces, aggregates, and rootwads per 100 m
III	Length, diameter, and percent submerged of single pieces	Mean diameter of single pieces Mean length of single pieces Volume of single pieces Percent submerged volume of single pieces Total number of pieces in aggregates

(con.)

Level	Variable	Summary output
II, III	Riparian community types	Number of occurrences of riparian community type for left and right banks, and total
		Percent occurrence of riparian community type for left and right banks, and total
		Percent stream length of riparian community type for left and right banks, and total (length)[a]
I-III	Comments	No summary outputs (output is a listing of the comments)
II, III	Side channel variables	Same as main channel outputs (above) for those variables collected in side channels
II, III	Fish sampling variables	Total dive length
		Mean dive width
		Mean dive depth
		Mean dive maximum depth
		Total habitat area (length, width)[a]
		Percent habitat area (length, width)[a]
		Total habitat volume (length, width, avg. depth)[a]
		Percent habitat volume (length, width, avg. depth)[a]
		Mean percent undercut bank
		Mean percent overhead cover
		Mean percent submerged cover
		Mean percent large substrate
		Count and number per 100 m for age/size class and total for selected salmonids
		Comments

[a]Variables in parentheses are all those needed to calculate the summary output.

Overton, C. Kerry; Wollrab, Sherry P.; Roberts, Bruce C.; Radko, Michael A. 1997. R1/R4 (Northern/Intermountain Regions) fish and fish habitat standard inventory procedures handbook. Gen. Tech. Rep. INT-GTR-346. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 73 p.

This handbook describes the standard inventory procedures for collecting fish habitat and salmonid fish species data for streams managed by the Northern (R1) and Intermountain (R4) Regions of the Forest Service, U.S. Department of Agriculture. The inventory procedures are designed to define and quantify the structure, pattern, and dimensions of fish habitat; describe salmonid species composition, distribution, and relative abundance; and facilitate the calculation of summary statistics for habitat descriptors.

Keywords: stream channels, quantifiable and repeatable parameters, fish composition and relative abundance, habitat typing, habitat variables, channel features

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